

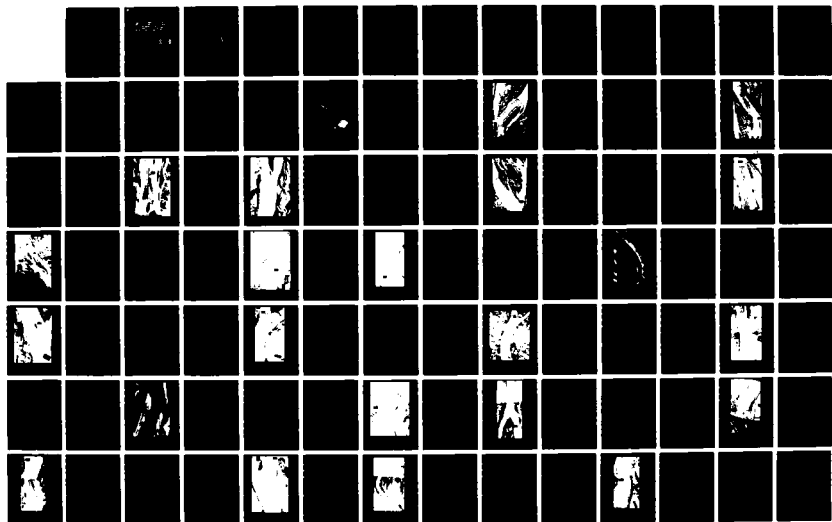
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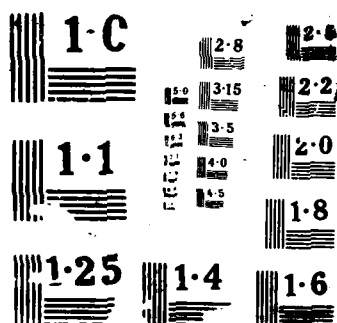
SURVEY OF FRESHWATER MUSSELS (PELECYPODA: UNIONACEA) AT 1/3  
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**Survey of Freshwater Mussels  
(Pelecypoda: Unionacea)  
at Selected Sites in  
Pools 11 through 24  
of the Mississippi River**

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ELECTE

JAN 05 1988

PREPARED FOR  
ROCK ISLAND DISTRICT  
CORPS OF ENGINEERS

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ECOLOGICAL ANALYSTS, INC

SURVEY OF FRESHWATER MUSSELS  
(PELECYPODA: UNIONACEA)  
AT SELECTED SITES IN  
POOLS 11 THROUGH 24  
OF THE MISSISSIPPI RIVER

DTIC  
ELECTE  
JAN 05 1988  
S D D

Prepared for

Department of the Army  
Rock Island District, Corps of Engineers  
Clock Tower Building  
Rock Island, Illinois 61201

Prepared by

Ecological Analysts, Inc.  
Midwest Regional Office  
1500 Frontage Road  
Northbrook, Illinois 60062

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## 1.0 INTRODUCTION

In the early 1800s, the Upper Mississippi River was a labyrinth of running sloughs, side channels, chutes and river lakes. The main channel of the river had many snags and was extremely shallow in some sections. The Des Moines Rapids, extending upstream from Keokuk, Iowa, and the Rock Island Rapids, near Rock Island, Illinois, were the most dangerous passages in the river. Despite the difficulties in navigation, there was heavy traffic on the Mississippi River.

The U.S. government authorized maintaining a 4.5-ft navigation channel in the Upper Mississippi River in 1878. Dredging the riverbed and constructing exposed wing dams and closing dams helped to direct the river flow into the main channel. These channel border alterations resulted in reduced flow and increased sedimentation in habitats out of the channel. Other navigation improvements included constructing a canal to bypass the Des Moines Rapids and excavating a channel through the bedrock of the Rock Island Rapids.

In 1907, Congress authorized deepening the main channel to a minimum of six feet to accommodate larger towboats. The increased depth was accomplished by constructing more wing dams, by increasing dredging and by building locks at the Rock Island and Des Moines rapids. These alterations further accelerated the diversion of river flow into the main channel and intensified sedimentation outside of the channel. Some areas of the Mississippi have been elevated greater than 20 feet by the increased deposition of silt and sand over wing dams (Fremling et al. 1979). In 1913 a lock and dam was completed at Keokuk, Iowa, to form the Keokuk pool. The Des Moines Rapids was submerged by this pool and the depth of the river was increased to a maximum of 52 feet immediately upstream from the dam (USACOE 1974). Additional navigation improvements included the Le Claire Canal and Lock, which were completed in 1922 to by-pass the upper portion of the Rock Island Rapids.

The use of increasingly larger towboats and barges soon made the 6-ft channel obsolete. In 1930 Congress authorized construction of the present lock and dam system of the Mississippi River. The navigation channel was maintained at a minimum depth of nine feet and a width of 400 feet. The resulting contiguous pools probably caused the most dramatic habitat changes in the Mississippi River in that they destroyed much of the remaining lotic habitats in the river and created greater shallow backwater habitats. During this relatively short period, the Upper Mississippi River was changed from a diverse fluvial ecosystem with a variety of habitats to a predominantly uniform river-lake type of environment. The combined impact of all past navigation improvements and the present levee system have resulted in the containment of most of the river's flow into relatively narrow channel and channel border habitats.

The U.S. Army Corps of Engineers (USACOE) initiated studies of the Mississippi River mussel fauna in 1977. These studies were prompted because there was concern that USACOE channel maintenance activities might adversely impact populations of mussels in the river; of particular concern was Lampsilis higginsii, a species that is listed as Endangered by the Federal Government.

Havlik and Stansbery (1977) reported the collection of 14 L. higginsii in a Corps dredge spoil disposal site in 1976, and the data suggested that this Endangered species could be threatened by routine navigation channel-maintenance activities. The initial Corps-supported surveys were conducted in 1977-1978 by Fuller (1978) and Freitag (1978). These two studies involved detailed surveys of USACOE dredge sites to document the occurrence, distribution and abundance of mussel populations at channel maintenance sites. They emphasized rare and Endangered species and included site specific recommendations for mitigative measures to be employed during channel dredging and spoil placement.

The present study is a continuation of the Corps' effort to evaluate mussel populations, particularly rare or Endangered species, in channel maintenance areas and to determine mitigative alternatives to minimize any possible deleterious impacts. Thirty-two sites in the USACOE Rock Island District of the Mississippi River were examined in 1979 and 1980. Twenty-nine of these sites had a history of channel maintenance activity or were scheduled for maintenance operations in the near future. In addition, three areas supporting commercially valuable mussel beds were surveyed for comparative purposes. Primary emphasis at each survey area was placed on documenting the occurrence of special status species. Special status species include: 1) mussels which are now listed as federally protected Endangered species; 2) mussels under Notice of Review for possible addition to the U.S. List of Endangered and Threatened Wildlife and Plants; or 3) rare species which may occur in the Mississippi River. The nationally Endangered species L. higginsii, Lampsilis orbiculata and Proptera (=Potamilus) capax; the species under Notice of Review, Cumberlandia monodonta and Leptodea leptodon; and the rarely collected species Simpsoniconcha ambigua are mussels which have been recorded in this region of the Mississippi River and qualify as special status species.

Secondly, mussel populations in general were evaluated at each site in relation to the impact of potential channel maintenance activities. At each site, mussels were surveyed using a variety of techniques and ancillary parameters such as depth, current velocity and substrate type were measured and recorded. A detailed literature survey was also conducted and several individuals with expertise in Mississippi River mussel fauna and Corps operations were interviewed during the course of the study.

Data and information gathered during this study are presented in a user-organized format. Each site and mussel species have been addressed separately, thereby enabling the reader who is interested in a particular pool, site or species to rapidly isolate pertinent information. The report also contains summary sections that synthesize (in a necessarily general fashion) all the information regarding proposed channel maintenance, its predicted impacts, and procedures for mitigation of impacts.

Sections 3.0 through 6.0 constitute the main body of the report and are preceded by a detailed summary of field and analytical procedures (Section 2.0). Section 3.0, Site Descriptions, summarizes historical channel maintenance activities, describes survey techniques employed, presents results of the mussel survey and reviews available historical information pertinent to the site. In addition, Section 3.0 outlines potential impacts at specific

sites and suggests mitigative measures. In each site discussion, the data table and figure of the collection locations are arranged facing each other to facilitate data interpretation.

Section 4.0, Species Summaries, is divided into two subsections. The first subsection is devoted to Special Status mussel species in the Mississippi River and the second subsection addresses, in decreasing order of abundance, each of the remaining species collected. Each species within these two subsections is discussed separately; attention is given to the relative abundance of each taxon in the present survey and to its historical abundance and habitat preferences. In addition, each species' current status and overall potential for survival, as assessed by Fuller (1980), is reviewed.

Section 5.0 is a synthesis of Sections 3.0 and 4.0. This section first presents a historical review of navigation channel construction and maintenance and summarizes the navigational alterations in habitat and resultant faunal changes that have occurred. Secondly, this section addresses potential dredging and spoil disposal effects at the Corps maintenance sites and summarizes available mitigative alternatives for consideration in future maintenance operations.

The final section, Section 6.0, Recommendations, presents specific precautions and mitigative measures recommended for employment at the USACOE maintenance sites. In addition, topics deserving further investigation are presented.

## 2.0 METHODS AND MATERIALS

Freshwater mussels (Pelecypoda: Unionacea) were surveyed at 32 sites in the U.S. Army Corps of Engineers (USACOE) Rock Island District of the Upper Mississippi River in 1979 and 1980 (Figure 1). These sites included 29 USACOE channel-maintenance areas and three mussel beds that were surveyed for comparative purposes. Sampling was conducted in August through October 1979 and May through October 1980. The sites surveyed and their respective pools and river mile locations are listed below.

1. Goetz Island	(Pool 11, RM 612.2-613.1)
2. St. Louis Woodyard	(Pool 11, RM 609.9-611.1)
3. Finley's Landing	(Pool 11, RM 595.3-596.6)
4. Gordon's Ferry	(Pool 12, RM 564.5-566.1)
5. Sand Prairie	(Pool 13, RM 549.8-551.1)
6. Maquoketa Levee	(Pool 13, RM 547.1-548.5)
7. Lainsville Lower	(Pool 13, RM 540.3-541.2)
8. Beaver Island	(Pool 14, RM 515.9-517.1)
9. Albany	(Pool 14, RM 513.3-514.2)
10. Steamboat Slough	(Pool 14, RM 503.2-504.1)
11. Winnebago Island	(Pool 15, RM 489.3-490.2)
12. Lock and Dam 15 Lower Approach	(Pool 16, RM 482.1-482.9)
13. Centennial Bridge	(Pool 16, RM 481.3-482.1)
14. Buffalo Towhead	(Pool 16, RM 472.0-473.1)
15. Hershey Chute	(Pool 16, RM 460.9-461.7)
16. Big Timbers	(Pool 17, RM 444.7-445.4)
17. Jonas Johnson Island	(Pool 17, RM 438.5-441.2)
18. New Boston	(Pool 18, RM 433.4-435.2)
19. Huron Island	(Pool 18, RM 424.0-424.6)
20. Benton Island	(Pool 18, RM 418.7-419.6)
21. Rush Island	(Pool 19, RM 404.4-407.1)
22. Warsaw Harbor	(Pool 20, RM 358.8-359.4)
23. Gregory Lower	(Pool 20, RM 351.2-353.1)
24. Buzzard Island	(Pool 20, RM 347.5-349.0)
25. LaGrange	(Pool 21, RM 335.6-337.3)
26. Hogback Island	(Pool 21, RM 331.7-332.8)
27. Lone Tree Light	(Pool 21, RM 330.9-331.5)
28. Lock and Dam 21 Lower Approach	(Pool 22, RM 323.4-324.2)
29. Northeast Missouri Power Station	(Pool 22, RM 319.8-320.5)
30. Beebe Island	(Pool 22, RM 316.0-316.7)
31. Turtle Island	(Pool 22, RM 311.1-311.9)
32. Lock and Dam 22 Lower Approach	(Pool 24, RM 299.8-301.1)

The sampling techniques employed at each site were contingent upon the types of habitats encountered. A 10-ft brail, or crowfoot bar, was employed in all deep-water areas. In addition, 0.5 square meter quadrat samples were hand-picked by a diver in the deep-water habitats with large mussel densities. Shallow environments were sampled by various types of hand collections that included wading, pollywogging and raking. During wading collections, shallow areas (0 to 3 feet) were searched for mussels by sight and touch. In pollywogging collections, mussels could be felt and removed from the substrate by crawling, floating, or diving in shallow water (2 to 6 feet). The mussel rake used was a modified garden rake with a collection basket of one-quarter inch wire mesh (Figure 2).

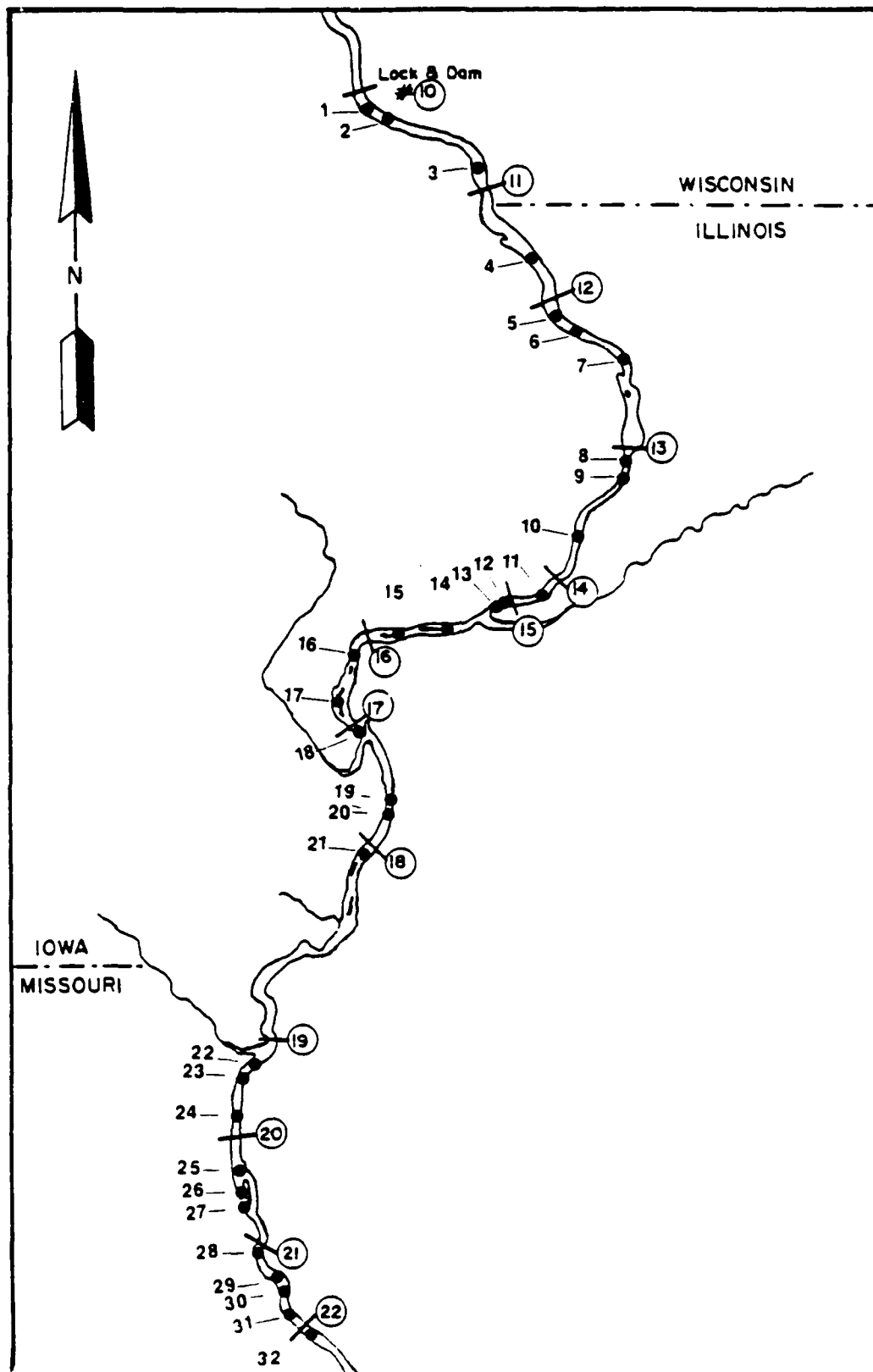


Figure 1. Freshwater mussel survey sites in the Rock Island District of the Mississippi River, 1979-1980.



Figure 2. Mussel rake used in the 1979-1980 mussel survey of the Upper Mississippi River.



At each channel maintenance site, brailing was conducted along transects in the area of the proposed dredge cut, and in nearby historic and future disposal areas. Brailing transects ranged from 500 feet to several thousand feet in length dependent upon the area in question. Brailing along each transect was divided into a series of 500-ft runs. The standardized 500-ft runs facilitated comparisons of brailing results between locations and sites. Buoys or shoreline stakes were placed in the collection area to delineate the sampling locations. The distance of the brail transect from shore was determined with a Rangematic Mark V range finder or TOPCON No. A282 range finder. In the laboratory these transects were plotted on aerial photographs of each site. These photographs, which were obtained from the U.S. Fish and Wildlife Service, are illustrated in each site discussion in this report.

The river bottom along each transect was sampled with a Petite Ponar grab sampler. Visual characterizations were made of each grab sample utilizing the soil particle size classification described by the U.S. Environmental Protection Agency (USEPA) (Weber 1973). Water temperature and depth were determined with a Whitney thermometer. In this report, depth measurements were converted to feet below flat pool elevation. Subsurface current velocity was measured using a Marsh-McBirney Model 201 current meter.

Scuba diving was employed whenever a special status species was encountered within the sampling area. Random 0.5 square meter quadrat samples were collected to determine the relative abundance of the mussel assemblage, especially the special status species. Six replicate samples were handpicked at each diving site. The substrate within the frame was removed to a depth of six inches, placed in a screened bucket, and brought to the surface to be sorted and analyzed.

The shoreline of the historic and future terrestrial disposal sites was sampled by various hand collecting techniques. The entire shoreline and the immediate downstream area were surveyed. Open water disposal sites were sampled by brailing.

The mussels collected at each site were identified and enumerated at the time of collection and data were recorded on field notes. Systematics followed shell characteristics described by Baker (1928), Burch (1975), Clarke (1973), La Rocque (1967), Parmalee (1967), and Starrett (1971). The familial classification of the freshwater mussels was according to Burch (1975). The nomenclature of the species primarily followed La Rocque (1967). The exceptions were the species Amblema peruviana and Anodonta corpulenta from Parmalee (1967) and the forms of Lampsilis anodontoides (L. a. anodontoides and L. a. fallaciosa) described in Starrett (1971). The federally Endangered species collected in this survey were photographed, measured and aged, then returned to the river in the area where they were collected. Individuals of each species were measured (height and length) and aged from each pool. Ages were determined by counting the number of annuli on the snells (Stansbery 1961). Representative specimens of each taxon, except Endangered species, were retained from each pool. Individuals were relaxed in propylene phenoxitol, then fixed and preserved in buffered formalin. These voucher specimens will be submitted to the U.S. National Museum of Natural History at the Smithsonian Institution.

### 3.0 SITE DESCRIPTIONS

#### 3.1 POOL 11

Mussels were investigated at three sites in Pool 11 during the 1979-1980 mussel survey. The Goetz Island (RM 612-613) and St. Louis Woodyard Sites (RM 609-611) are both situated in the upstream sections of the pool near Guttenberg, Iowa. The third site, Finley's Landing (RM 595-596), is located in the middle region of Pool 11. Each of these three sites is scheduled for future channel maintenance dredging. Mussel surveys were designed primarily to assess the impact of specific historic and proposed dredge cuts and spoil disposal areas at each site.

##### 3.1.1 Goetz Island Site

The Goetz Island Site, located approximately 2.0 miles downstream of Lock and Dam 10, was dredged five times from 1945 through 1961 (USACOE 1974). The volumes dredged from this area have been relatively small (usually <40,000 cubic yards) when compared to other sites in Pool 11. Four transects (A through D) were established for brailing (5,000-ft runs) in the main channel and channel border at the proposed dredge cut site (Figure 3).

During previous dredging operations, the spoil material was placed at sites along the shore west of the channel and along the island east of the channel. Transects E, F and G were established for sampling mussels at these two spoil disposal sites (Figure 3). Additional qualitative hand collection effort was expended at Locations H and I to further characterize the mussel fauna near these historic and potential disposal areas (Figure 3).

The main channel area in the proposed dredge site had a maximum depth of approximately 20 feet at flat pool. Substrates were primarily fine sand in the main channel. Shallower depths (approximately 16 feet) were found along the inside bend of the river in the main channel. Along the island shore (Transects E and F and Location I), substrates were primarily silty sand; however, rubble substrates occurred near wing dams. A mixed sand and silt substrate was encountered along the west shore disposal site (Transect G and Location H).

A total of 19 freshwater mussel species and 345 individuals were collected at the Goetz Island Site during June 1980 (Table 1). Included in the collection were two individuals of the federally Endangered Lampsilis higginsii. Main channel brail runs in the area of the potential dredge cut (Transects B, C and D) yielded no freshwater mussels; however, brailing (Transect F) and hand collections (Location I) along the island shoreline resulted in the collection of several mussel species. Numerous juveniles of Truncilla donaciformis, Carunculina parva and Amblema peruviana were collected by their byssal threads on brail runs 40 to 60 feet from shore. The byssal threads serve to anchor the young in the current when they are too small to maintain their position by other means (Kirtland 1840). There were large fluctuations in water depth due to the wing dams along this shore. Hand collections near the island shoreline (maximum depth of three feet) yielded numerous A. peruviana, Fusconaia undata, and Lampsilis ventricosa.



Figure 3. Collector locations near the contact between the basal 11' of the "Hastings Formation" and the "Hastings Formation" (see text for details).

Table 1. Freshwater mussels collected near the Goetz Island Site in Pool 11 of the Mississippi River (RM 612.2-613.1), June 1980.

Organism	Brail Transect <sup>a</sup>							Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	H	I	
UNIONIDAE										
AMBLEMINEAE										
AMBLEMA PERUVIANA	27	0	0	0	0	0	53	39	17	136
A. PERUVIANA JUV.	0	0	0	0	0	3	0	3	0	6
FUSCONAIA UNDATA	6	0	0	0	0	0	17	20	28	71
MEGALONAIAS GIGANTEA	0	0	0	0	0	3	1	0	0	4
QUADRULA PUSTULOSA	3	0	0	0	1	0	5	0	3	12
Q. QUADRULA	4	0	0	0	0	0	4	0	0	8
UNIONINAE										
ANODONTA CORPULENTA	1	0	0	0	0	0	0	2	0	3
A. IMBECILLIS	0	0	0	0	0	0	0	1	0	1
A. IMBECILLIS JUV.	0	0	0	0	0	0	0	1	0	1
CARUNCULINA PARVA JUV.	0	0	0	0	0	4	0	0	1	5
ELLIPTIO DILATATUS	0	0	0	0	0	0	1	0	0	1
LAMPSILIS HIGGINSII	0	0	0	0	0	0	1	1	0	2
L. VENTRICOSA	0	0	0	0	0	0	0	0	10	10
L. VENTRICOSA JUV.	0	0	0	0	0	0	0	1	0	1
LEPTODEA FRAGILIS	0	0	0	0	0	0	1	0	3	4
L. FRAGILIS JUV.	1	0	0	0	0	0	0	0	0	1
L. LAEVISSIMA	0	0	0	0	0	0	0	0	5	5
OBLIQUARIA REFLEXA	1	0	0	0	0	0	2	0	4	7
OBOVARIA OLIVARIA	2	0	0	0	0	0	1	0	0	3
PROPTERA ALATA	0	0	0	0	0	0	0	4	1	5
STROPHITUS UNDULATUS	0	0	0	0	0	0	1	0	0	1
TRUNCILLA DONACIFORMIS	0	0	0	0	0	1	0	3	8	12
T. DONACIFORMIS JUV.	5	0	0	0	0	30	3	0	0	38
T. TRUNCATA	3	0	0	0	0	0	0	4	1	8
TOTAL IN EACH SAMPLE	53	0	0	0	1	41	90	79	81	345

<sup>a</sup>Transect A, 5000 ft brail run, main channel border, west shore side.

Transect B, 5000 ft brail run, main channel, dredge site.

Transect C, 5000 ft brail run, main channel, dredge site.

Transect D, 5000 ft brail run, main channel, dredge site.

Transect E, 5000 ft brail run, main channel border, east shore side.

Transect F, 5000 ft brail run, main channel border, historic and potential east shore disposal site.

Transect G, 2000 ft brail run, main channel border, historic and potential west shore disposal site.

<sup>b</sup>Location H, hand collecting, nearshore, historic and potential west shore disposal site.

Location I, hand collecting, nearshore, historic and potential east shore disposal site.

A diverse and relatively abundant mussel assemblage was found immediately downstream from the west shore disposal area (Transect G and Location H). Amblema peruviana and F. undata were the most commonly collected species. In addition, two male L. higginsii and one individual of the uncommon Strophitus undulatus were recorded from this location. Elliptio dilatatus, which is primarily found in the northern portion of the Upper Mississippi River (van der Schalie and van der Schalie 1950), was collected only at this site during the 1979-1980 survey. This mussel assemblage was not considered commercially valuable. The mussels were concentrated in a small area near Location H and the densities were lower than those recorded at the comparison mussel bed sites at Big Timbers and New Boston (see Sections 3.7.1 and 3.8.1).

During a 1979 survey of Pool 11, the Wisconsin Department of Natural Resources (DNR) reported no freshwater mussels in this section of the Mississippi River (Wisconsin DNR 1979). A 1980 Iowa Conservation Commission (ICC) survey conducted upstream from the Goetz Island Site (RM 614.3-614.8) revealed 11 mussel species (Ackerman 1980). The ICC survey reported several individuals of Quadrula nodulata. This species was not reported in the present study at the Goetz Island Site. Lampsilis higginsii was not reported in the ICC survey upstream of the Goetz Island Site.

The occurrence of the Endangered L. higginsii along the west shoreline creates concern regarding the impact of future USACOE activity at the Goetz Island Site. Dredging probably would have little effect on the population since the dredge cut would be made in the Wisconsin portion of the channel. However, dredge spoil placed at the Iowa shore disposal site could have deleterious effects on this Endangered species as a result of increased downstream sedimentation. For this reason it is recommended that the spoil be placed at an alternate site.

### 3.1.2 St. Louis Woodyard Site

The St. Louis Woodyard Site is situated just downstream of the Goetz Island Site. This potential dredge site is approximately 26.9 miles upstream of Lock and Dam 11 and runs to within 3.9 miles of Lock and Dam 10. Channel maintenance dredging was conducted seven times at the St. Louis Woodyard Site from 1945 to 1962 (USACOE 1974). Five 5,000-ft brailling transects (Transects A through E) were positioned in the main channel and channel border to evaluate mussels in the probable dredge cut site (Figure 4).

Historically, the dredge spoil was placed on islands along both the west and east sides of the channel immediately adjacent to the dredge cut (Figure 4). Both these areas will probably be utilized for future spoil placement. Transect F and Locations G and H were established to characterize the mussel fauna near these two probable spoil disposal areas.

The main channel in the proposed dredge site contained a mixed fine and medium sand substrate. Depth varied from 10 to 19 feet at flat pool. The sediment along the island disposal site on the east side of the channel was predominantly sand except for areas of rubble near wing dams. A sandy substrate was also encountered along the island disposal site on the west side of the channel.

Nineteen freshwater mussel species and 417 individuals were collected at the St. Louis Woodyard Site during June 1980 (Table 2). Brailing runs within the main channel and main channel border area (Transects A, B, C, D and E) yielded only five taxa and a total of 13 mussels. Obovaria olivaria was the most abundant species taken in the main channel and channel border habitats. A single young Quadrula metanevra was collected by brailing at Transect B near RM 610.7. This was the only individual of Q. metanevra encountered at the St. Louis Woodyard Site.

Brailing on Transect F along the east island disposal site (approximately 55 to 75 feet from shore) also produced very few individuals. Pollywogging and raking at Location G along this disposal site, however, yielded 17 species and a total of 318 mussels. Amblema peruviana and Fusconaia undata were the predominant mussels encountered; they composed over 50% of the mussel assemblage. Other abundant species collected along this island were Lampsilis ventricosa, Leptodea fragilis, Leptodea laevisima, Obliquaria reflexa and Truncilla donaciformis. Juveniles of the above species and several juveniles of Carunculina parva, collected by their byssal threads, were included in the collection at this disposal site. Hand collections also yielded an adult and juvenile Lampsilis radiata siliquoidea. This species was rarely encountered during the 1979-1980 survey of the Rock Island District. Many young and adults of A. peruviana and F. undata along with several Proptera alata were collected by pollywogging near the wing dam just downstream of the disposal site.

A relatively diverse assemblage was also noted in samples collected by hand along the shore of the west island disposal site (Location H). Fusconaia undata was the predominant mussel collected. This species constituted over 60% of the assemblage. Amblema peruviana, L. laevisima and T. donaciformis were also abundant. Brailing approximately 80 feet offshore at this same location yielded no mussels.

Exploratory sampling near Cassville, Wisconsin, approximately two miles downstream from the St. Louis Woodyard Site, yielded 20 specimens of the Asiatic clam, Corbicula fluminea, in October 1980. Sampling was conducted along the shoreline immediately downstream from the Nelson Dewey Electrical Generating Station at RM 607.1-607.8. In the present survey of Pool 11, Corbicula was only collected at this sampling site.

Nine brailing runs by the Wisconsin DNR (1979) along both sides of the river at the St. Louis Woodyard Site yielded only one O. olivaria and one Quadrula nodulata. Downstream at RM 608.9 the Wisconsin DNR (1979) reported collecting numerous specimens by brailing and diving. The predominant species were A. peruviana, F. undata, Truncilla truncata, T. donaciformis and Quadrula pustulosa. Two individuals of the Endangered species Lampsilis higginsii were collected by the Wisconsin DNR by diving at this site. Perry (1979) also reported a live specimen of L. higginsii collected by Ackerman (ICC) above the mouth of the Turkey River at RM 607.6. During a 1977 survey just downstream from the St. Louis Woodyard Site, Fuller (1978) collected 11 taxa, all represented in the present survey. Amblema peruviana and F. undata were also the dominant mussels collected by Fuller.

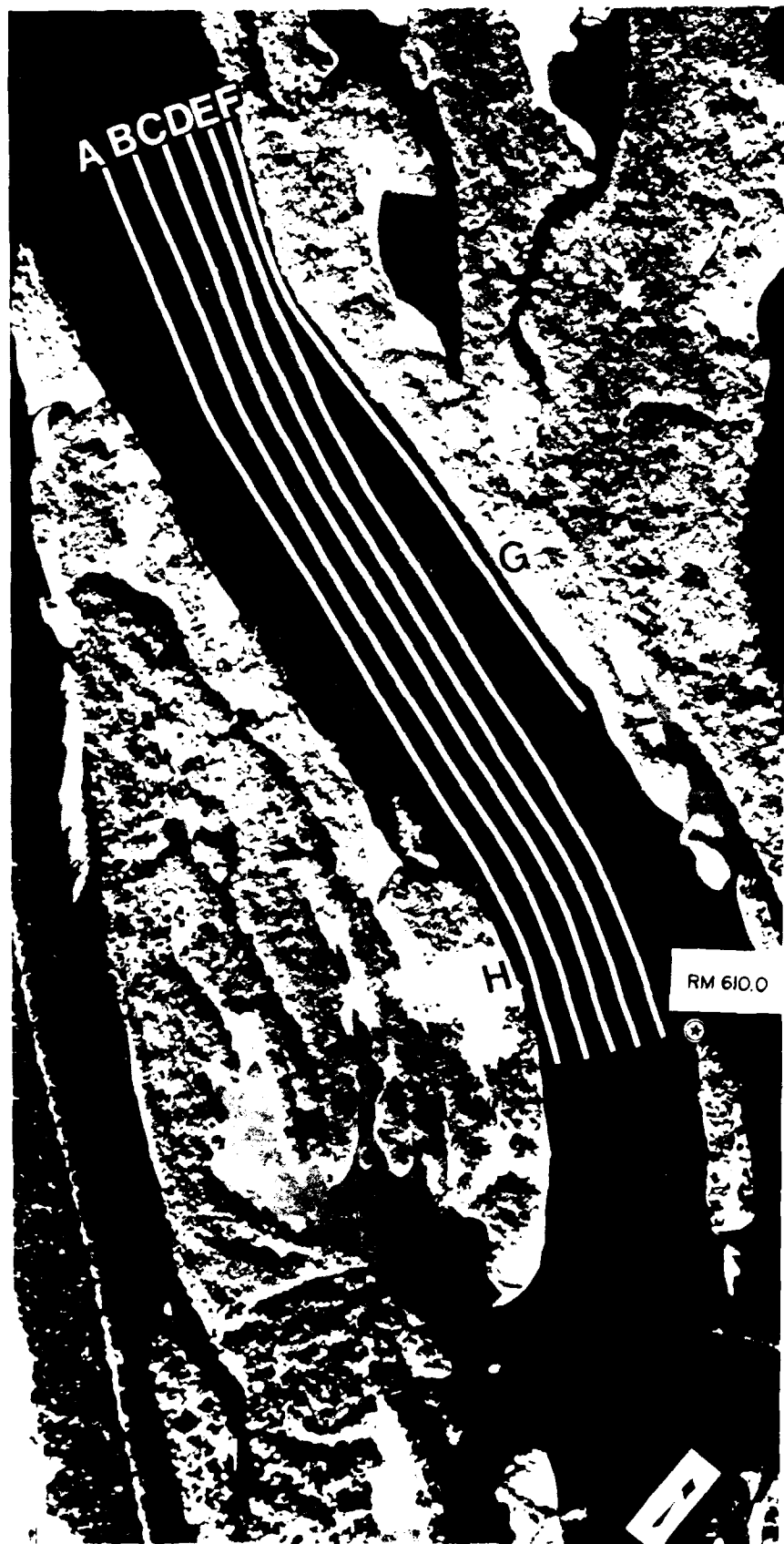


Figure 4. Collection locations near the Jackson Ward Site in Pool 11 of the Mississippi River. All collection sites are 19.5.

Table 2. Freshwater mussels collected near the St. Louis Woodyard Site in Pool 11 of the Mississippi River (RM 609.9-611.1), June 1980.

Organism	Brail Transect <sup>a</sup>						Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	H	
UNIONIDAE									
AMBLEMINAE									
AMBLEMA PERUVIANA	0	0	0	0	0	2	85	5	92
A. PERUVIANA JUV.	0	0	0	0	0	0	12	0	12
FUSCONAIA UNDATA	0	0	0	0	0	0	74	49	123
F. UNDATA JUV.	0	0	0	0	0	0	12	0	12
QUADRULA METANEVRA	0	1	0	0	0	0	0	0	1
Q. MODULATA	1	0	0	0	0	1	0	0	2
Q. PUSTULOSA	1	1	0	0	0	0	11	2	15
Q. QUADRULA	0	0	0	0	0	0	1	0	1
Q. QUADRULA JUV.	0	0	0	0	0	0	1	0	1
UNIONINAE									
ANODONTA CORPULENTA	0	0	0	0	0	0	3	0	3
A. CORPULENTA JUV.	0	0	0	0	0	0	2	0	2
A. IMBECILLIS	0	0	0	0	0	0	2	0	2
CARUNCULINA PARVA	0	0	0	0	0	0	3	1	4
C. PARVA JUV.	0	0	0	0	0	0	3	0	3
LAMPSILIS RADIATA									
SILYQUOIDEA	0	0	0	0	0	0	2	0	2
L. VENTRICOSA	0	0	0	0	0	0	15	3	18
L. VENTRICOSA JUV.	0	0	0	0	0	0	2	1	3
LASMIGONA COMPLANATA	0	0	0	0	0	0	1	0	1
LEPTODEA FRAGILIS	0	0	0	0	0	0	15	2	17
L. FRAGILIS JUV.	0	0	0	0	0	0	3	1	4
L. LAEVISSIMA	0	0	0	0	0	0	14	5	19
OBLIQUARIA REFLEXA	0	0	0	0	0	1	14	2	17
OBOVARIA OLIVARIA	3	4	0	0	1	4	1	1	14
PROPTERA ALATA	0	0	0	0	0	0	5	0	5
TRUNCILLA DONACIFORMIS	0	0	0	0	0	0	23	5	28
T. DONACIFORMIS JUV.	1	0	0	0	0	0	0	0	1
T. TRUNCATA	0	0	0	0	0	0	14	1	15
TOTAL IN EACH SAMPLE	6	6	0	0	1	8	318	78	417

<sup>a</sup>Transect A, 5000 ft brail run, main channel border, west shore side.

Transect B, 5000 ft brail run, main channel, dredge site.

Transect C, 5000 ft brail run, main channel, dredge site.

Transect D, 5000 ft brail run, main channel, dredge site.

Transect E, 5000 ft brail run, main channel border, east shore side.

Transect F, 3500 ft brail run, historic and potential east shore disposal site.

<sup>b</sup>Location G, hand collecting, nearshore, historic and potential east shore disposal site.

Location H, hand collecting and brail, nearshore, historic and potential west shore disposal site.



Dredging by the Corps of Engineers probably will have little effect upon mussel populations at the St. Louis Woodyard Site because of the sparse number of mussels in the area of the potential dredge cut. Care should be taken, however, with spoil placement at the east island disposal site in light of the high concentrations of mussels along the shore of this island.

Although no special status species were collected in this survey of the St. Louis Woodyard Site, the Endangered *L. higginsii* has been reported one mile downstream (Wisconsin DNR 1979). This downstream area also has a history of dredging activity and probably will be a future dredge site. It is recommended that any future dredging or dredge spoil placement in this area (RM 608.9) be limited to the east side of the river.

### 3.1.3 Finley's Landing Site

The Finley's Landing Site (RM 595-596) is located in the middle portion of Pool 11. This future channel maintenance area is approximately 12.3 miles upstream from Lock and Dam 11 and 18.5 miles downstream from Lock and Dam 10. Although no dredging was conducted at this site between 1945 and 1973 (USACOE 1974), this area has required channel maintenance since this period (R.M. Baker, USACOE, personal communication, 30 March 1981). Dredging is anticipated in the main channel in the area encompassed by brailing Transects B, C, D and E (Figure 5). Spoil material from future channel dredging probably will be placed along the Iowa shore in the vicinity of the historic disposal site (Location F) which is now utilized as a recreational beach. Transect A was brailed (1,500-ft run) and Location F was sampled by hand collecting to evaluate mussel fauna at this probable disposal site.

The substrates of the main channel (Transects C and D) and the Iowa main channel border (Transects A and B) were primarily fine sand. Depths in the main channel varied from 13 to 17 feet. The Wisconsin main channel border area (Transect E) varied from a primarily rubble, deep-water habitat at the upstream end to a shallow, silty area along the middle portion, and a sandy gravel substrate at the downstream section. In the sheltered embayment, immediately downstream from the Iowa shore disposal, the substrate was a clay, silt and sand mixture, whereas the shoreline of the disposal site was predominantly silty sand.

Eighteen mussel species representing 324 individuals were collected at the Finley's Landing Site during June 1980 (Table 3). No Endangered or other special status species were present. *Ambelma peruviana* was the dominant species in collections from this site. No mussels were collected from the sandy main channel. Brailing was unproductive along the Iowa main channel border (Transect B); however, numerous mussels were collected along the Wisconsin main channel border (Transect E). The most abundant mussels along this transect were *A. peruviana*, *Quadrula quadrula*, *Quadrula pustulosa*, *Obovaria olivaria* and *Fusconaia undata* (in decreasing order of abundance). The mussels were especially abundant near the downstream end of this transect. Brailing yielded few individuals along the Iowa shore disposal (Transect A), and pollywogging and raking along the shoreline was unproductive. Numerous species were recorded from the protected area at the downstream end of the disposal site (Location F). Ten species were collected representing a total of 97 individuals. *Ambelma peruviana* was the predominant mussel collected in this assemblage. The uncommon species, *Lampsilis radiata siliquoidea*, was also observed at this location.

The Wisconsin DNR (1979) conducted eight brail runs in the channel border habitats of this site during 1979 and collected a total of 118 mussels among ten species. No Endangered or other special status species were recorded here by the Wisconsin DNR; however, they did find a specimen of Lampsilis higginsii approximately one mile upstream. Fuller (1978) also surveyed the area upstream from Finley's Landing at RM 597.6-599.4. He reported a total of 21 taxa and 364 individuals, but did not collect any special status species. Ackerman (United States Fish & Wildlife Service 1980) reported 20 species from RM 599.0-600.5 in 1979 but found no Endangered species.

Data from the present study and other recent surveys indicated that the Corps of Engineers channel maintenance activity would not influence any Endangered or special status species at the Finley's Landing Site. However, the mussel fauna at the lower end of the Iowa shore disposal and the mussel assemblage along the Wisconsin channel border habitat at the end of Transect E should be protected against spoil encroachment or siltation in any future spoil disposal.

### 3.2 POOL 12

The navigation channel within Pool 12 has required little maintenance in the past. Only a few dredge sites, requiring infrequent, low-volume dredging, occur in Pool 12. Gordon's Ferry Site (RM 564-566) was the only potential dredge site examined during the 1979-1980 mussel survey.

#### 3.2.1 Gordon's Ferry Site

This site is located in the lower half of Pool 12 near the mouth of the Galena River approximately 9.4 miles above Lock and Dam 12. The site was dredged on only two occasions between 1945 and 1973 (USACOE 1974). The dredge cut at this site will be along the entire shipping channel at the lower end of the site where a large amount of sand accretion has occurred. Mussels were surveyed by brailing (5,500-ft runs) along Transects A, B, C and D (Figure 6). Historically, disposal sites have been in the deep, open water areas along the Illinois shore in the former main channel. Future spoil may be placed at this same deep-water area along the Illinois shore, in deep areas of the main channel downstream from the dredge cut, or at the upstream Illinois island. Brailing transects E, F and G and Location H were established to evaluate mussel populations in and near these probable disposal sites (Figure 6).

The main channel (Transects B, C and D) had a substrate of fine to medium grain sand. Depths in the main channel ranged from 17 to 19 feet at the upstream end of the site to 9 to 10 feet at the lower end. The substrate along the Iowa channel border (Transect A) varied from sandy gravel upstream to silty sand downstream. The open water disposal areas at Transects E, F and G varied in depth from 12 to 25 feet and had a predominantly sandy bottom with minor amounts of clay. The nearshore sediment of the Illinois island disposal area (Location H) was primarily fine sand.

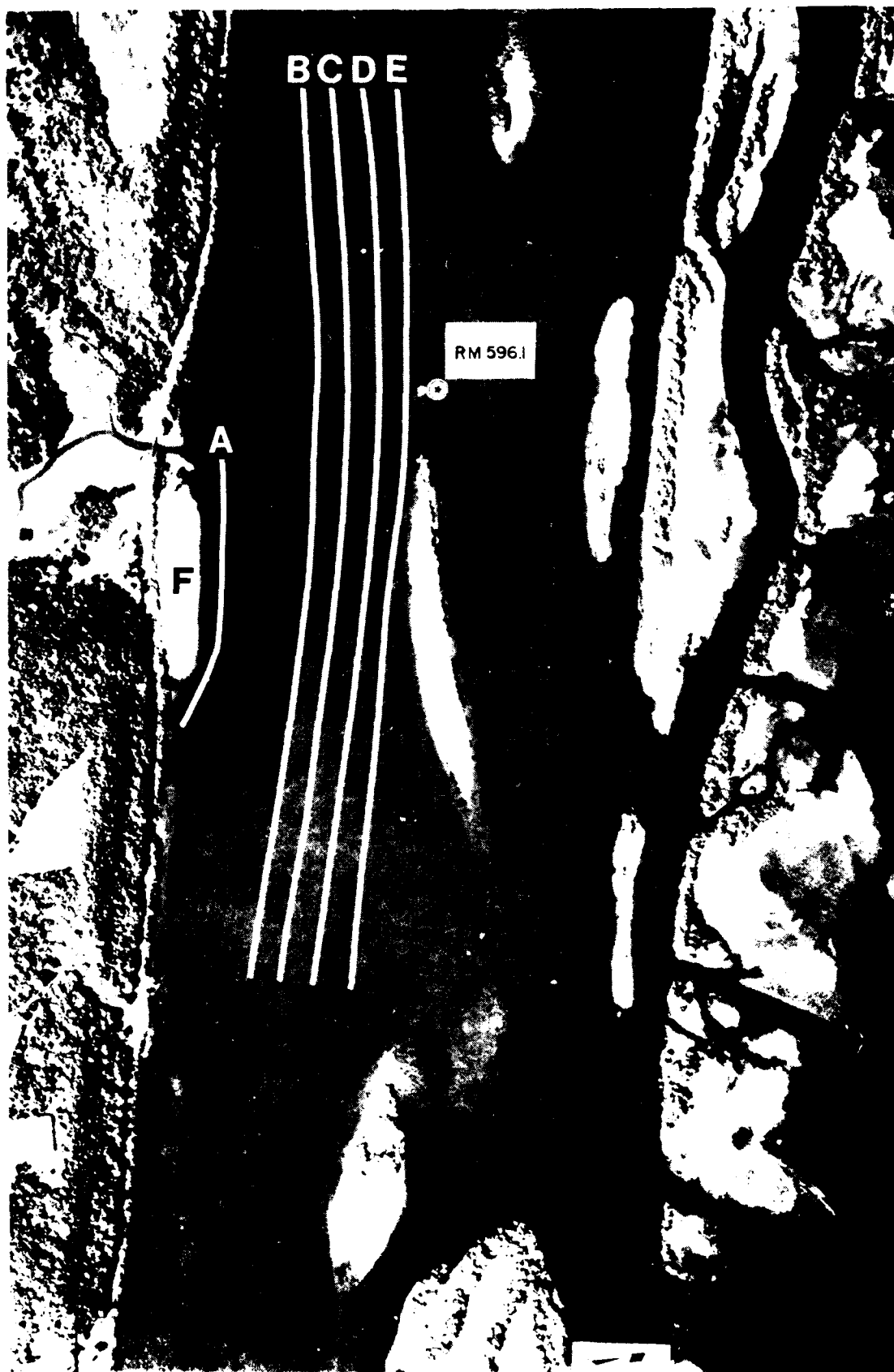


Figure 5. Collection locations near the Finley's Landing Site in Pool 11 of the Mississippi River (RM 595.3-596.6), June 1980.

Table 3. Freshwater mussels collected near the Finley's Landing Site in Pool 11 of the Mississippi River (RM 595.3-596.6), June 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	
UNIONIDAE							
AMBLEMINAE							
AMBLEMA PERUVIANA	12	0	0	0	102	53	167
FUSCONAIA UNDATA	1	0	0	0	18	3	22
QUADRULA NODULATA	0	0	0	0	5	0	5
Q. PUSTULOSA	0	0	0	0	20	0	20
Q. QUADRULA	0	0	0	0	30	0	30
UNIONINAE							
ANODONTA CORPULENTA	1	0	0	0	0	6	7
ARCIDENS CONFRAGOSUS	0	0	0	0	3	0	3
CARUNCULINA PARVA	0	0	0	0	0	3	3
LAMPSILIS RADIATA							
SILICOIDEA	0	0	0	0	0	1	1
L. VENTRICOSA	0	0	0	0	1	1	2
LEPTODEA FRAGILIS	1	0	0	0	0	5	6
L. LAEVISSIMA	0	0	0	0	0	3	3
L. LAEVISSIMA JUV.	0	0	0	0	0	1	1
OBLIQUARIA REFLEXA	1	0	0	0	6	0	7
OBOVARIA OLIVARIA	0	0	0	0	19	0	19
PLAGIOLA LINEOLATA	1	0	0	0	0	0	1
PROPTERA ALATA	0	0	0	0	0	9	9
TRUNCILLA DONACIFORMIS	0	0	0	0	3	12	15
T. TRUNCATA	1	0	0	0	2	0	3
TOTAL IN EACH SAMPLE	18	0	0	0	209	97	324

<sup>a</sup>Transect A, 1500 ft brail run, main channel border, historic and potential Iowa disposal site.

Transect B, 5500 ft brail run, main channel border, Iowa side.

Transect C, 5500 ft brail run, main channel, dredge site.

Transect D, 5500 ft brail run, main channel, dredge site

Transect E, 5500 ft brail run, main channel border, Wisconsin side.

<sup>b</sup>Location F, hand collecting, nearshore, historic and potential Iowa disposal site.

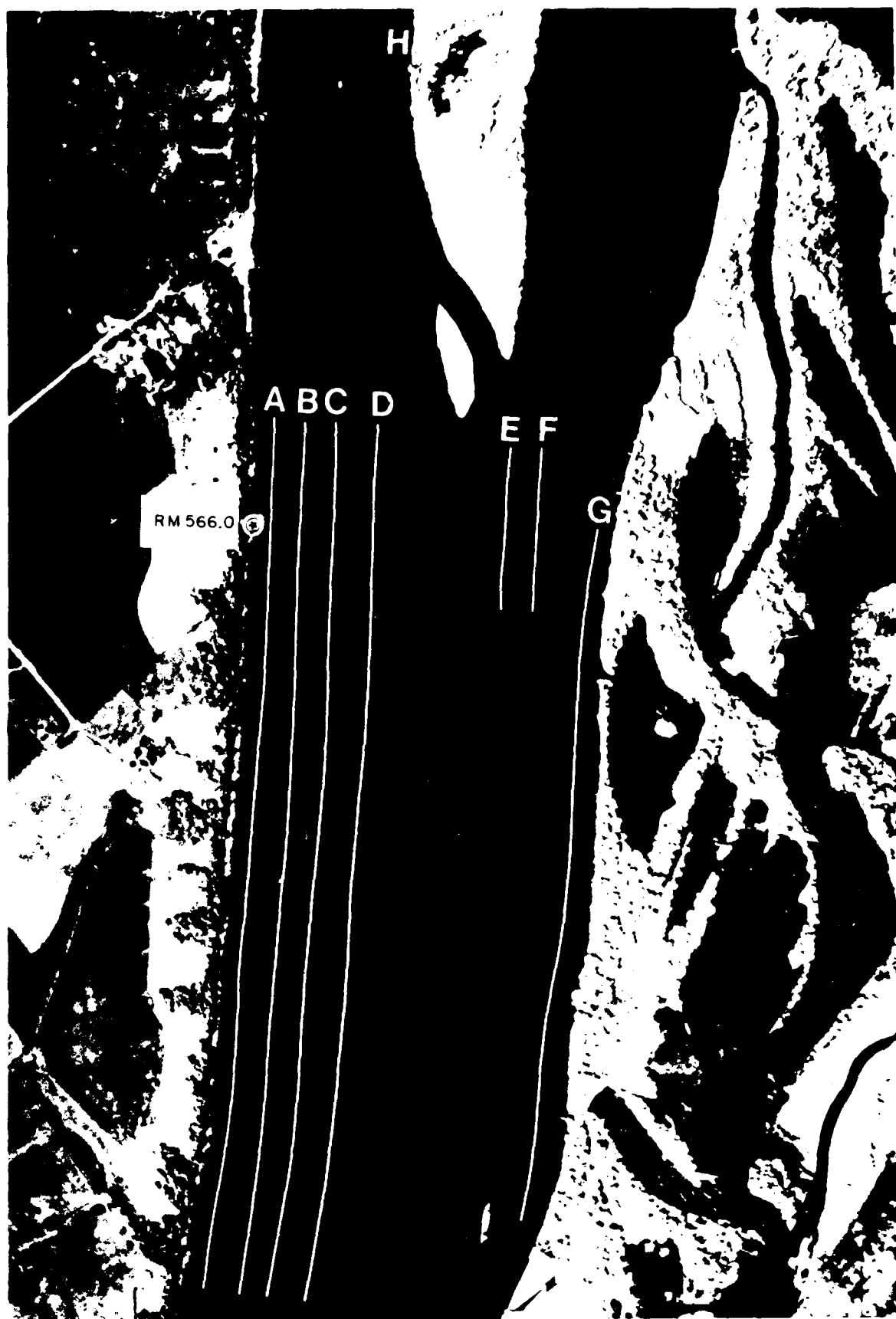


Figure 6. Collection locations near the Gordon-Lerry Site in Pool 12 of the Mississippi River (RM 564.5-566.1), August 1979.

Table 4. Freshwater mussels collected near the Gordon's Ferry Site in Pool 12 of the Mississippi River (RM 564.5-566.1), August 1979.

Organism	Brail Transect <sup>a</sup>						Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	H	
UNIONIDAE									
AMBLEMINAE									
AMBLEMA PERUVIANA	21	0	0	0	1	1	7	0	30
FUSCONAIA UNDATA	5	0	0	0	0	1	2	0	8
MEGALONAIAS GIGANTEA	20	0	0	0	0	0	0	0	20
QUADRULA NODULATA	1	0	0	0	0	0	2	0	3
Q. PUSTULOSA	0	0	0	1	2	0	3	0	6
Q. QUADRULA	12	0	0	0	0	0	1	0	13
UNIONINAE									
ANODONTA CORPULENTA	2	0	0	0	0	0	0	0	2
ARCIDENS CONFRAGOSUS	1	0	0	0	0	0	0	0	1
LAMPSILIS VENTRICOSA	23	2	2	1	0	1	7	0	36
LEPTODEA FRAGILIS	2	1	0	0	0	0	0	0	3
L. LAEVISSIMA	2	0	0	0	1	0	1	0	4
OBLIQUARIA REFLEXA	0	1	0	0	0	0	1	0	2
OBOVARIA OLIVARIA	7	5	2	4	3	3	7	0	31
PROPTERA ALATA	3	1	0	0	0	0	1	0	5
STROPHITUS UNDULATUS	0	0	0	0	0	0	1	0	1
TOTAL IN EACH SAMPLE	99	10	4	6	7	6	33	0	165

<sup>a</sup>Transect A, 5500 ft brail run, main channel border, Iowa side, potential dredge site.

Transect B, 5500 ft brail run, main channel, dredge site.

Transect C, 5500 ft brail run, main channel, dredge site.

Transect D, 5500 ft brail run, main channel, dredge site.

Transect E, 1000 ft brail run, main channel border, Illinois side, historic disposal site.

Transect F, 1000 ft brail run, main channel border, Illinois side, historic disposal site.

Transect G, 4500 ft brail run, main channel border, Illinois side, historic and potential disposal site.

<sup>b</sup>Location H, hand collecting, nearshore, Illinois island potential disposal site.

Fifteen species representing 165 mussels were collected at the Gordon's Ferry Site during August 1979 (Table 4). No Endangered or special status species were present at this site. The main channel yielded 20 mussels in 5,500-ft brail runs on Transects B, C and D. The fauna of the main channel was considered relatively abundant in comparison to other sandy main channel habitats in this study. Obovaria olivaria and Lampsilis ventricosa, which are commonly found in sand substrate (Parmalee 1967), were the most abundant mussels in the main channel. These species were also common in the sandy downstream portion of Transect A. The upstream gravelly section of this transect was dominated by the thick-shelled species, Ambelma peruviana and Megalonia gigantea. Mussels were collected throughout the entire length of Transect A near the Iowa shore, but they were never abundant (maximum of 17 individuals/500-ft run). Brailing at the open water disposal sites (Transects E, F and G) disclosed sporadic occurrences of mussels, but no large concentrations. A diverse mussel assemblage, including the uncommon species Strophius undulatus, was collected along Transect G. Hand collecting failed to yield any mussels near the Illinois island disposal site (Location H).

There are no existing data concerning the mussel fauna in this portion of Pool 12; however, considerable work has been conducted upstream near Dubuque, Iowa (USFWS 1980). Two specimens of the Endangered Lampsilis higginsii were collected in these surveys. In exploratory sampling conducted by the authors near Dubuque, 21 individuals of the Asiatic Clam, Corbicula fluminea, and single representatives of Carunculina parva and Truncilla donaciformis were collected during October 1980. These species were collected in shoreline rake samples immediately downstream of the Interstate Power Company electrical generating station at RM 579.9. In the present survey of Pool 12, Corbicula was only collected at this site.

The absence of special status species at the Gordon's Ferry Site precludes any possible impacts on these species from localized channel maintenance activities. The presence of a variety of other mussel species along the Iowa main channel border (Transect A), however, suggests that care should be taken to confine the dredge cut to the main channel.

### 3.3 POOL 13

Mussels were surveyed at three sites; Sand Prairie, Maquoketa Levee and Lainsville Lower, in Pool 13. Sand Prairie Site is situated in the upstream portion of the pool and has required frequent dredging in recent years. The Maquoketa Levee Site, also located in the upper section of Pool 13, has sustained recurrent large-volume dredging. Lainsville Lower Site is positioned near the middle of Pool 13. Channel maintenance at Lainsville Lower has been required only occasionally within recent years.

#### 3.3.1 Sand Prairie Site

The Sand Prairie Site is situated at RM 549-551 near Bellevue, Iowa, 5.6 miles downstream of Lock and Dam 12. Dredging was conducted at this site on four occasions between 1945 and 1973 (USACOE 1974). Brailing runs (each 4000 feet) were conducted along Transects A, B, C, D and E in the main channel and channel border near the proposed dredge cut (Figure 7). During past maintenance operations, spoil material has been placed along the Iowa shore in the

Pleasant Creek Wildlife Refuge and on the Illinois islands in the Savanna Proving Grounds. Mussels were collected by hand at Location G to evaluate the possible impact of spoil disposal on the Illinois island area (Figure 7).

Substrates in most main channel and channel border areas of the proposed dredge site were predominantly fine sand. The downstream section of Transect A was in a wing dam area and substrates varied from silty sand to rubble. The downstream portions of Transects D and E contained silty sand substrates. The river bottom along the Illinois island disposal site was also primarily silty sand. The main channel depths varied from 13 to 17 feet. The area downstream from the dredge site (Location F) contained a sandy-gravel substrate.

Four hundred and three mussels of 18 species were recorded from the Sand Prairie Site during June and August 1980 (Table 5). No mussels were collected in the proposed dredge cut area of the main channel (Transects B and C). Brailing in the channel border habitats (Transects A and D) and near the Illinois islands disposal site (Transect E) yielded only 10 mussels comprising three species. Pollywogging 5 to 15 feet from the Illinois island disposal site at Location G resulted in the collection of nine species and a total of 83 mussels (Table 5). Leptodea laevis, Amblema peruviana, Fusconaia undata and Lampsilis ventricosa (in decreasing order of abundance) were the predominant species in this silty sand habitat. An extensive mussel assemblage was located downstream from the Sand Prairie Site near the Illinois shore at Location F (Table 5). Amblema peruviana and F. undata dominated the mussel collection at this deep-water location, which included 14 species representing a total of 310 mussels. A single individual of the uncommon Strophitus undulatus was recorded from this downstream location. No Endangered or other special status species were observed near the Sand Prairie Site during this survey.

An unspecified habitat immediately downstream from the Sand Prairie Site (RM 550.2) was investigated by Helms during 1975 (Perry 1979). The study reported a total of nine species, including Arcidens confragosus, Leptodea fragilis and Proptera alata. These species were not collected in the present site survey. Helms also surveyed an upstream site at RM 554.0 during 1975, recording 15 total species. Actinonaias carinata and Elliptio dilatatus, which have not been commonly reported in Pool 13, were collected at this upstream site.

Considering the relatively sparse mussel community near the Sand Prairie Site and the absence of Endangered species, the potential channel dredging at this site will not appreciably alter the mussel fauna in this portion of the Mississippi River. Spoil placement on the Illinois island disposal site will be in close proximity to a diverse nearshore mussel assemblage. Care should be taken to mitigate spoil encroachment or siltation upon the mussel assemblage identified in the vicinity of Location G in the present study.

There were substantial numbers of mussels collected approximately 0.5 mile downstream from the site (Location F), but this community is probably out of the influence of any future dredging at the Sand Prairie Site.





Figure 7. Collection 1, station 1, near the and from the site in Fig. 13 of the Miscellaneous Report of the U.S. Geological Survey, 1964, p. 10, fig. 10.

Table 5. Freshwater mussels collected near the Sand Prairie Site in Pool 13 of the Mississippi River (RM 549.8-551.1), June and August 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINEAE								
AMBLEMA PERUVIANA	1	0	0	3	1	123	20	148
FUSCONAIA UNDATA	0	0	0	3	1	88	12	104
MEGALONAIAS GIGANTEA	0	0	0	0	0	1	0	1
QUADRULA METANEVRA	0	0	0	0	0	1	0	1
Q. NODULATA	0	0	0	0	0	0	1	1
Q. PUSTULOSA	0	0	0	0	0	15	0	15
Q. QUADRULA	0	0	0	0	0	16	0	16
UNIONINAE								
ANODONTA CORPULENTA	0	0	0	0	0	1	7	8
A. IMBECILLIS	0	0	0	0	0	0	3	3
LAMPSILIS VENTRICOSA	0	0	0	0	0	0	10	10
LEPTODEA LAEVISSIMA	0	0	0	0	0	0	22	22
LIGUMIA RECTA LATISSIMA	0	0	0	0	0	1	0	1
OBLIQUARIA REFLEXA	0	0	0	0	0	3	7	10
OBOVARIA OLIVARIA	1	0	0	0	0	19	1	21
PLAGIOLA LINEOLATA	0	0	0	0	0	2	0	2
STROPHITUS UNDULATUS	0	0	0	0	0	1	0	1
TRUNCILLA								
DONACIFORMIS JUV.	0	0	0	0	0	13	0	13
T. TRUNCATA	0	0	0	0	0	26	0	26
TOTAL IN EACH SAMPLE	2	0	0	6	2	310	83	403

<sup>a</sup>Transect A, 4000 ft brail run, main channel border, Iowa side.

Transect B, 4000 ft brail run, main channel, dredge site.

Transect C, 4000 ft brail run, main channel, dredge site.

Transect D, 4000 ft brail run, main channel border, Illinois side.

Transect E, 4000 ft brail run, main channel border, Illinois disposal site.

<sup>b</sup>Location F, brail runs, main channel border, Illinois side, exploratory site.

Location G, hand collecting, nearshore, Illinois disposal site.

### 3.3.2 Maquoketa Levee Site

The Maquoketa Levee Site (RM 547-548) is situated 8.2 miles downstream from Lock and Dam 12 near the mouth of the Maquoketa River. This site was dredged 13 times between 1945 and 1973 (USACOE 1974), most recently in the summer of 1980. Large volumes (<100,000 cubic yards) have been removed from the channel in several maintenance operations. Transects A, B, C and D (6,000-ft mussel brailing runs) were established in the area of the recurrent dredging (Figure 8).

Historically, dredge spoil has been placed in open water areas near brail transects E and F; along the Illinois shoreline near sampling Locations G and H; or along the Green Island levee and the Iowa shoreline. The spoil from 1980 maintenance operations and future dredge spoil will be put on the land side of the Green Island levee.

The main channel dredge cut area had a fine to coarse sand substrate, and depth varied from 14 to 24 feet. The historic open water disposal site (Transects E and F) was situated along two wing dams near the Illinois shore. Depth at this disposal site was 7 to 8 feet, and silty sand substrates were prevalent between the rubble wing dams. The Illinois island disposal sites (Locations G and H) had predominantly sand substrates that were utilized as recreational beach areas.

The survey of the Maquoketa Levee Site during 1979 resulted in the collection of 13 species representing 86 individuals (Table 6). No rare or Endangered species were encountered at this site. The mussel fauna in the main channel and main channel border near the proposed dredge cut was sparse (Transects A, B, C and D). This was expected because of the recurrent dredging and shifting sand bedload in this area. Species with a preference for sand (*Lampsilis ventricosa*, *Leptodea* spp. and *Obovaria olivaria*) were the only mussels found in this rigorous habitat (Table 6). Numerous sub-fossil shells were observed along the Iowa shore disposal site suggesting this area may have been densely populated in the past. Live mussels were also scarce at the open water disposal site; however, the disposal sites on the Illinois islands offered a diverse assortment of juvenile and adult mussels (Table 6). Small backwater bays in this area with stable silty substrates yielded numerous mussels. A sandy shoal with emergent vegetation downstream from the disposal island (Location G) also produced several young individuals.

The occurrence of *Corbicula fluminea* at this site marked the northernmost point at which the species was collected in the absence of a heated effluent. The absence of special status species and the sparse mussel fauna in the area of future dredging and spoil disposal areas suggests that channel maintenance activities will have little impact upon mussels at the Maquoketa Levee Site.

### 3.3.3 Lainsville Lower Site

The Lainsville Lower Site (RM 540-541) is situated near the middle of Pool 13 just upstream of Savanna, Illinois. This potential dredge site is approximately 17.8 miles upstream of Lock and Dam 13 and 15.5 miles downstream of Lock and Dam 12. Channel maintenance dredging has only been conducted twice at the Lainsville Lower Site between 1945 and 1973 (USACOE 1974). Brail runs

were conducted along Transects A, B, C, D and E to survey mussels in the dredge cut area (Figure 9). In the past, spoil has been placed adjacent to the dredge site on Santa Fe Island, on the island immediately upstream from Santa Fe Island (Location F), and along the Iowa shoreline. Future disposal probably will be at the past disposal sites on the Illinois side and on a small island on the Iowa side just upstream of Kellers Island (Location G). The latter site was identified as an area in need of fill for bank stabilization.

Substrates in the dredge cut area graded from coarse gravel materials on the outside of the riverbend (where currents were greatest), to medium and coarse sand in the main channel, and to fine sand and silt along the inside of the bend on the Illinois side. Depth in the main channel was 18 to 30 feet and decreased to 12 feet along the Illinois main channel border area.

A total of 356 mussels comprising 17 taxa were collected from the Lainsville Lower Site in June 1980 (Table 7). No Endangered or special status species were collected at this site. The majority of the mussels were collected from brailling runs along the Iowa main channel border (Transect A) and the Iowa side of the main channel (Transect B). Transect A yielded 12 taxa and a total of 196 individuals. The predominant species in this channel border habitat were (in decreasing order of abundance) Obovaria olivaria, Quadrula quadrula, Fusconaia undata, Amblema peruviana and Truncilla truncata. Brailling along Transect B in the main channel produced 134 individuals among 11 species. Obovaria olivaria accounted for 105 of the 134 mussels collected; the majority of this species was collected from two consecutive 500-ft brailling runs. Densities of this magnitude would represent a commercially valuable bed; however, O. olivaria is not of commercial importance.

Mussels were extremely sparse in collections from the Illinois main channel and channel border habitat. Brailling runs at Transects C, D and E yielded only one individual. Brailling and pollywogging in the main channel border area along Santa Fe Island and the upstream island disposal site yielded only 25 individuals among nine species. The majority of the mussels collected at this disposal site (Location F) were collected from the backwater area between the two islands (Figure 9). Amblema peruviana was the most abundant mussel collected in this potential disposal area. No mussels were collected along the proposed disposal island on the Iowa side of the river (Location G).

Few studies have been conducted on the mussel fauna near the Lainsville Lower Site. Fuller (1978) surveyed a downstream area (RM 537.2-539.1) and reported the occurrence of 20 taxa. Amblema peruviana and Truncilla donaciformis were the most abundant species in Fuller's collection. In a survey by the ICC at RM 540.6-541.4, no mussels were collected (Perry 1979). In 1902, a survey of the mussels near Savannah, Illinois reported 31 taxa, including a specimen of the special status species Leptodea leptodon (Baker 1903).

Dredging probably will have negligible impact upon the mussel fauna of this site. It is likely that dredging activity will be limited to the Illinois side of the channel where extremely sparse numbers of mussels were observed. On the Iowa side, where a dense mussel assemblage was observed, depth was sufficient for navigational purposes and will not require dredging at this time. Spoil disposal will also have little impact on the mussel fauna. Both the Illinois and Iowa disposal sites harbored sparse numbers of mussels.



Figure 8. Collection locations near the lowest water site in Pool 13 of the Mississippi River, all from the same collection event.

Table 6. Freshwater mussels collected near the Maquoketa Levee Site in Pool 13 of the Mississippi River (RM 547.1-548.5), August 1979.

Organism	Brail Transect <sup>a</sup>						Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	H	
CORBICULIDAE									
CORBICULA FLUMINEA	0	0	0	0	0	0	0	3	3
UNIONIDAE									
AMBLEMIDAE									
AMBLEMA PERUVIANA	0	0	0	0	3	3	9	1	16
A. PERUVIANA JUV.	0	0	0	0	0	0	1	2	3
FUSCONAIA UNDATA	0	0	0	0	0	2	1	1	4
F. UNDATA JUV.	0	0	0	0	0	0	1	9	10
QUADRULA PUSTULOSA	0	0	0	0	0	0	1	0	1
Q. QUADRULA	0	0	0	0	0	1	1	0	2
Q. QUADRULA JUV.	0	0	0	0	0	0	1	0	1
UNIONINAE									
ANODONTA CORPULENTA	0	0	0	0	0	2	0	0	2
LAMPSILIS VENTRICOSA	2	0	1	0	2	0	20	0	25
LEPTODEA FRAGILIS	0	0	0	1	0	0	1	0	2
L. LAEVISSIMA	1	1	0	0	2	0	1	0	5
L. LAEVISSIMA JUV.	0	0	0	0	0	0	1	0	1
OBLIQUARIA REFLEXA	0	0	0	0	0	1	0	2	3
OBOVARIA OLIVARIA	3	0	0	0	0	0	2	0	5
TRUNCILLA DONACIFORMIS	0	0	0	0	0	0	1	1	2
T. TRUNCATA	0	0	0	0	0	0	0	1	1
TOTAL IN EACH SAMPLE	6	1	1	1	7	9	41	20	86

<sup>a</sup>Transect A, 6000 ft brail run, main channel border, Iowa side, dredge site.  
 Transect B, 6000 ft brail run, main channel, dredge site.  
 Transect C, 6000 ft brail run, main channel, dredge site.  
 Transect D, 6000 ft brail run, main channel, dredge site.  
 Transect E, 3000 ft brail run, main channel border, Illinois side, historic disposal site.  
 Transect F, 3000 ft brail run, main channel border, Illinois side, historic disposal site.

<sup>b</sup>Location G, hand collecting and brail run, nearshore, Illinois side, historic disposal site.  
 Location H, hand collecting, nearshore, Illinois side, historic disposal site.

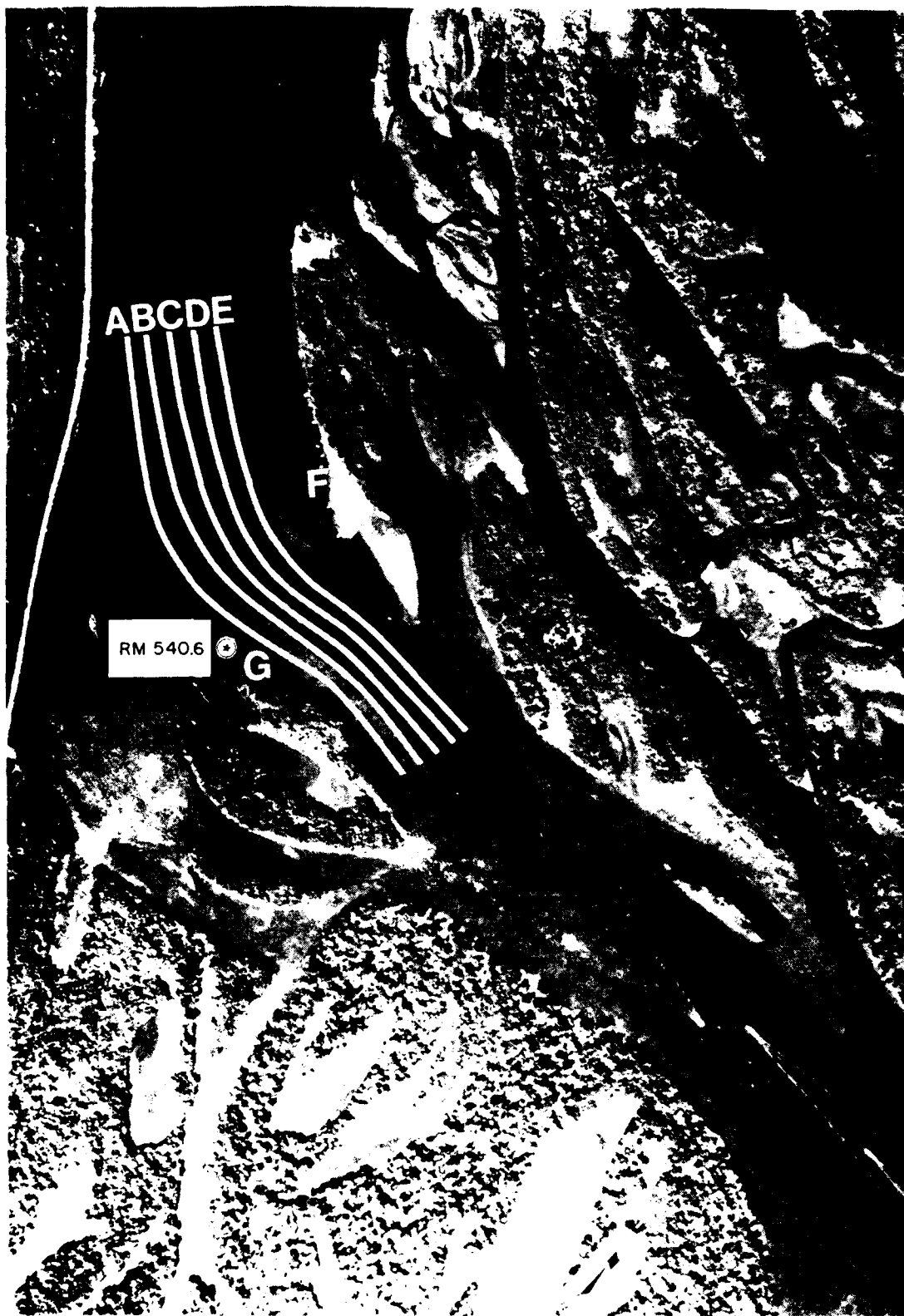


Figure 9. Collection locations near the Lainsville Lower Site in Pool 13 of the Mississippi River (RM 540.3-541.2), June 1980.

Table 7. Freshwater mussels collected near the Lainsville Lower Site in Pool 13 of the Mississippi River (RM 540.3-541.2), June 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINAE								
AMBLEMA PERUVIANA	20	5	0	0	0	11	0	36
FUSCONAIA UNDATA	35	3	0	0	0	2	0	40
MEGALONAIAS GIGANTEA	2	0	0	0	0	0	0	2
QUADRULA METANEVRA	0	1	0	0	0	0	0	1
Q. NODULATA	0	2	0	0	0	0	0	2
Q. PUSTULOSA	2	5	0	0	0	0	0	7
Q. QUADRULA	42	4	0	0	0	1	0	47
UNIONINAE								
ANODONTA CORPULENTA	0	0	0	0	0	1	0	1
A. IMBECILLIS	0	0	0	0	0	1	0	1
LAMPSILIS VENTRICOSA	2	5	0	1	0	2	0	10
LEPTODEA LAEVISSIMA	0	0	0	0	0	5	0	5
OBLIQUARIA REFLEXA	9	2	0	0	0	1	0	12
OBOVARIA OLIVARIA	59	105	0	0	0	0	0	164
PLAGIOLA LINEOLATA	2	1	0	0	0	0	0	3
STROPHITUS UNDULATUS	1	0	0	0	0	0	0	1
TRUNCILLA DONACIFORMIS	2	0	0	0	0	1	0	3
T. TRUNCATA	20	1	0	0	0	0	0	21
TOTAL IN EACH SAMPLE	196	134	0	1	0	25	0	356

<sup>a</sup>Transect A, 3000 ft brail run, main channel border, Iowa side (included two additional runs at upstream end of transect).

Transect B, 3000 ft brail run, main channel, dredge site (included one additional run in middle of transect).

Transect C, 3000 ft brail run, main channel, dredge site.

Transect D, 3000 ft brail run, main channel, dredge site

Transect E, 3000 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, hand collecting and brail, nearshore, historic and potential Illinois disposal site, near Santa Fe Island.

Location G, hand collecting, nearshore, potential Iowa disposal site.



### 3.4 POOL 14

Mussels were surveyed at three probable dredging sites within Pool 14. Two sites, Beaver Island near Clinton, Iowa, and the Albany Site near Albany, Illinois, are situated in the upper portion of the pool. Historically, only infrequent small volume dredging has been conducted at these two sites. The third channel maintenance area, Steamboat Slough near Cordova, Illinois, is located in the middle reach of Pool 14. Steamboat Slough has sustained recurrent large volume dredging operations.

#### 3.4.1 Beaver Island Site

The Beaver Island Site (RM 515-517) is approximately 5.4 miles downstream from Lock and Dam 13 and 22.6 miles upstream of Lock and Dam 14. This site includes several small historical dredge sites that were dredged four times between 1945 and 1973 (USACOE 1974). This site has required channel maintenance only once since 1955. The probable area of dredging was surveyed by brailing along Transects A, B, C and D (Figure 10). The disposal areas at this site have included the Iowa side of the river on Beaver Island and the Illinois shore. Brailing was conducted along Transect E and hand collecting was employed at Location F to evaluate the mussel fauna near the Illinois shoreline disposal site. Additional exploratory collections were also performed upstream along the Illinois shore at Location G (Figure 10).

Fine sand was the predominant substrate in the main channel areas at this site (Transects B, C and D), and depth ranged from 11 to 14 feet. Both the Illinois and Iowa channel border habitats had silty sand substrates. The river bottom dropped off rapidly along the Illinois shoreline. At Transect E, 150 feet from shore, depth was approximately 14 feet. Numerous snags were encountered during brailing along this transect. The shoreline of the Illinois disposal site was sandy; however, downstream from the disposal area and also in the shallow slough east of the main channel, the river bottom was a mixture of silt, sand and clay.

Brailing, raking and pollywogging in May and August 1980 yielded a total of 177 mussels comprising 14 species (Table 8). Endangered and special status species were not encountered in this survey. Mussels were scarce in the main channel and channel border habitats. Only ten individuals were collected in brail runs along Transects A, B, C, D and E (Table 8). Obovaria olivaria was observed in small numbers at Transects B, C, D and E. The river shoreline along the Illinois disposal area was void of mussels; however, immediately downstream from the disposal area at Location F, 148 individuals representing 10 species were collected. Amblema peruviana, Anodonta corpulenta and Obliquaria reflexa were the predominant species. Exploratory collections made upstream from the dredge site along the Illinois shore (Location G) produced 19 individuals among eight species.

The Illinois backwater area at RM 516.0 was brailed during 1976 by Perry (1979) but he failed to collect any mussels. Perry reported 13 species of mussels during 1975 at RM 515.5 downstream from the Beaver Island Site, including individuals of Quadrula metanevra and Plagiola lineolata. Neither of these species was observed in the present survey.

Future dredging will affect few mussels near the Beaver Island Site. No Endangered mussel species were observed during this survey, and mussel occurrence in general was sporadic in the area of the dredge cut. Dredge spoil disposal could, however, have a detrimental impact on the abundant mussel assemblage observed immediately downstream from the Illinois disposal site. Dredge spoil should be placed at the site so as not to disturb this downstream fauna.

#### Albany Site

The Albany Site is located approximately 8.3 miles downstream from Lock and Dam 13 and 20 miles upstream from Lock and Dam 14. This area was dredged only three times between 1945 and 1973 (USACOE 1974). Brailing was conducted along Transects A, B, C and D in the vicinity of the proposed dredge cut (Figure 11). Historically, the spoil has been placed along Beaver Island on the Iowa side of the channel or along the Illinois shore. Mussels along the Illinois disposal site were sampled by brailing (Transect E) and near-shore hand collecting (Location F).

The main channel and channel border areas near the proposed dredge cut (Transects A through D) contained fine and medium sand substrates, whereas Transect E (100 feet from the Illinois shore) had a mixed sand and rubble bottom. The Illinois disposal site (near Location F) was a recreational beach containing a substrate of sandy gravel. Depth in the main channel and channel border (Transects A through D) ranged from 13 to 15 feet. Depth was approximately 6 feet along Transect E, near the Illinois disposal site.

The Albany Site collections in June and August 1980 included 12 species representing 114 individuals (Table 9). No Endangered or other special status species were found. The fauna of the main channel and channel border habitats (Transects A through D) was sparse; only one individual was collected in four 4,500-ft brail runs. A relatively abundant, non-diverse, mussel fauna was observed along most of Transect E. Maximum densities along this transect were 51 mussels/500-ft run. Amblema peruviana was the dominant species. Pollywogging in 3 to 4 feet of water along the Illinois shoreline disposal area produced only four specimens but included two species, Leptodea laevis and Obliquaria reflexa, which were not collected at other sampling locations at this site.

As noted in the Beaver Island Site discussion, mussel surveys at RM 515.5 (1.3 miles upstream from the Albany Site) during 1975 yielded 13 species (Perry 1979). Differences in species composition were apparent between the assemblage reported by Perry and the present study. Only eight taxa were common to both surveys. The mussel community along the Illinois shore near RM 508.1-510.2 has been investigated by several researchers in recent years (USFWS 1980). This site, approximately 2.1 miles downstream from the Albany Site, did not have a large density or diversity of mussels; however, several live individuals of the Endangered Lampsilis higginsii have been observed in this portion of the river. Helms (Perry 1979) collected this species at RM 510.2 in 1977, Popowski (USFWS 1980) observed a male and a female Higgins' Eye at RM 509, and two specimens were recorded in 1976 and 1977 at RM 508.1 by Lewis and Brice (1977) and Lewis (1979).

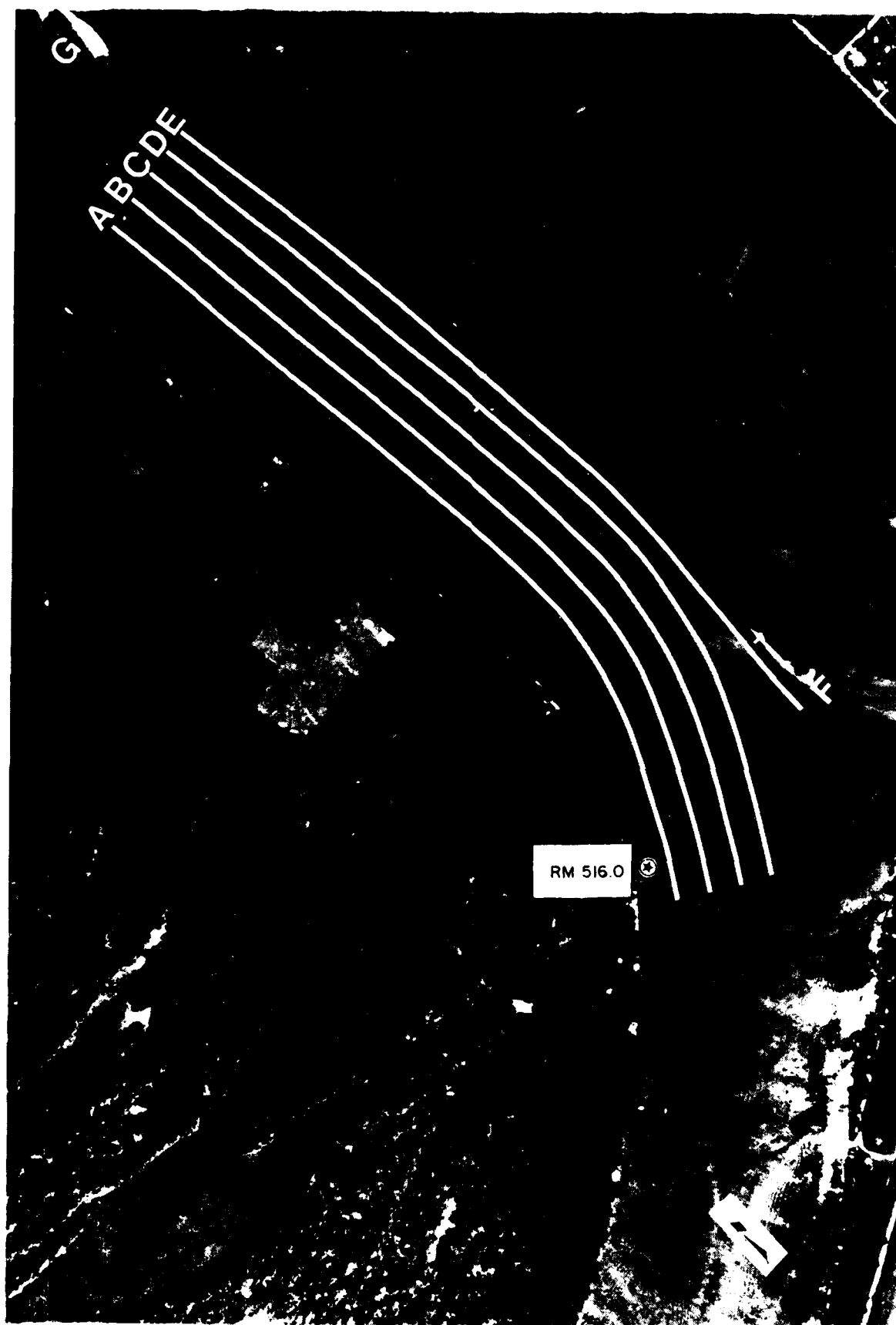


Figure 10. Collection locations near the Beaver Island Site in Pool 14 of the Mississippi River (RM 515.9-517.1), May and August 1980.

Table 8. Freshwater mussels collected near the Beaver Island Site in Pool 14 of the Mississippi River (RM 515.9-517.1), May and August 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINAE								
AMBLEMA PERUVIANA	0	0	0	0	3	54	6	63
FUSCONAIA UNDATA	0	0	0	0	1	3	4	8
QUADRULA PUSTULOSA	0	0	0	0	0	2	2	4
Q. QUADRULA	0	0	0	0	0	0	1	1
UNIONINAE								
ANODONTA CORPULENTA	0	0	0	0	0	49	1	50
A. IMBECILLIS	0	0	0	0	0	1	0	1
LAMPSILIS VENTRICOSA	1	0	0	0	0	1	3	5
LEPTODEA FRAGILIS JUV.	0	0	0	1	0	0	0	1
L. LAEVISSIMA	0	0	0	0	0	9	0	9
OBLIQUARIA REFLEXA	0	0	0	0	0	22	1	23
OBOVARIA OLIVARIA	0	1	1	1	1	0	0	4
PROPTERA ALATA	0	0	0	0	0	5	0	5
TRUNCILLA DONACIFORMIS	0	0	0	0	0	2	0	2
T. TRUNCATA	0	0	0	0	0	0	1	1
TOTAL IN EACH SAMPLE	1	1	1	2	5	148	19	177

<sup>a</sup>Transect A, 6000 ft brail run, main channel border, Iowa side.

Transect B, 6000 ft brail run, main channel, dredge site.

Transect C, 6000 ft brail run, main channel, dredge site.

Transect D, 6000 ft brail run, main channel, dredge site.

Transect E, 5000 ft brail run, main channel border, Illinois disposal site.

<sup>b</sup>Location F, hand collecting, nearshore, Illinois disposal site.

Location G, hand collecting, nearshore, Illinois side, exploratory site.

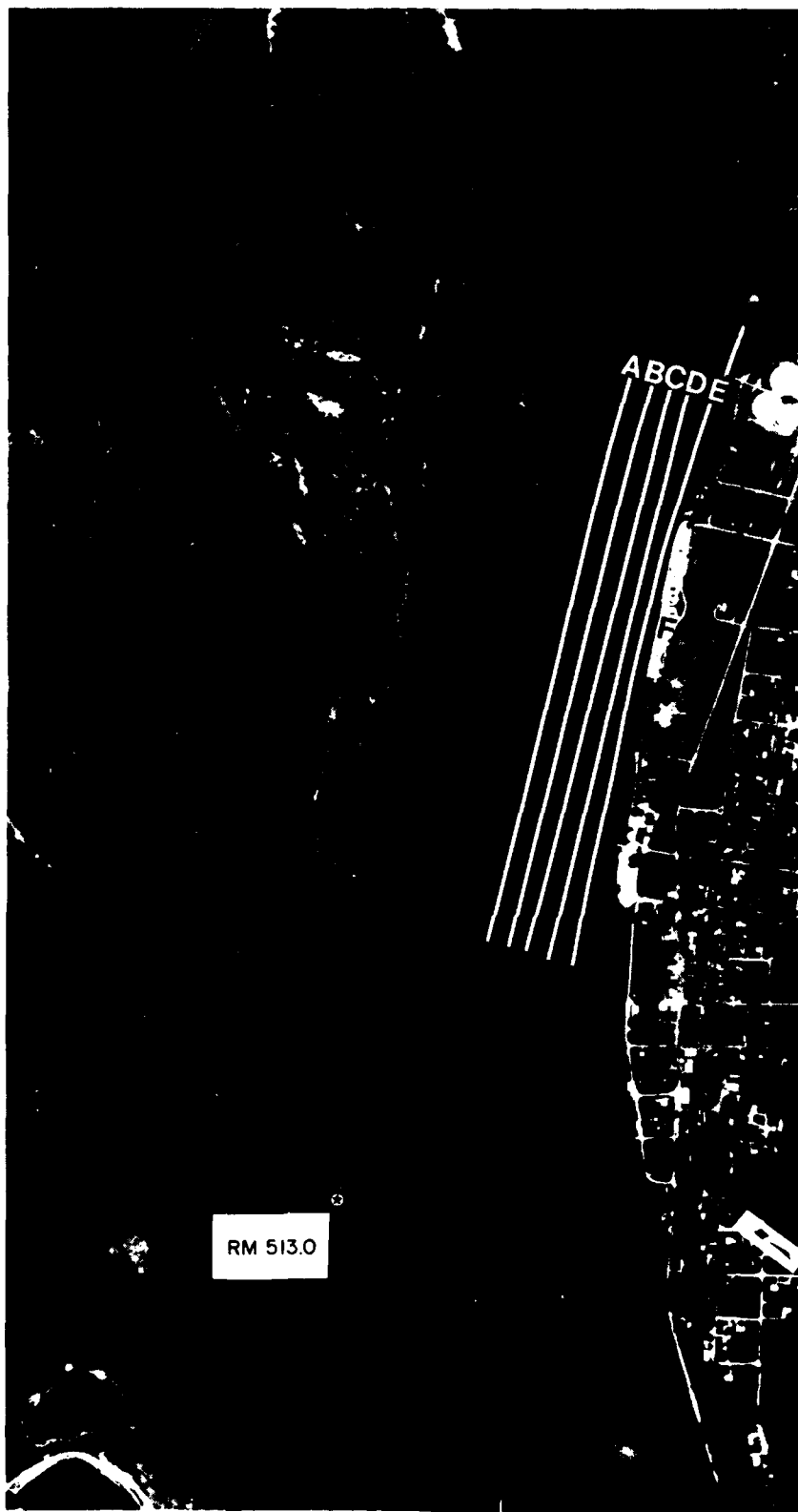


Figure 11. Collection locations near the Albany Site in Pool 14 of the Mississippi River (RM 513.3-514.2), June and August 1980.

Table 9. Freshwater mussels collected near the Albany Site in Pool 14 of the Mississippi River (RM 513.3-514.2), June and August 1980.

Organism	Brail <sup>1</sup> Transect <sup>a</sup>					Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	
UNIONIDAE							
AMBLEMINAE							
AMBLEMA PERUVIANA	1	0	0	0	62	0	63
FUSCONAIA UNDATA	0	0	0	0	14	0	14
MEGALONAIAS GIGANTEA	0	0	0	0	1	0	1
QUADRULA NODULATA	0	0	0	0	1	0	1
Q. PUSTULOSA	0	0	0	0	17	1	18
Q. QUADRULA	0	0	0	0	9	0	9
UNIONINAE							
ANODONTA CORPULENTA	0	0	0	0	1	0	1
LAMPSILIS VENTRICOSA	0	0	0	0	1	0	1
LEPTODEA LAEVISSIMA	0	0	0	0	0	1	1
OBLIQUARIA REFLEXA	0	0	0	0	0	2	2
OBOVARIA OLIVARIA	0	0	0	0	2	0	2
TRUNCILLA DONACIFORMIS	0	0	0	0	1	0	1
TOTAL IN EACH SAMPLE	1	0	0	0	109	4	114

<sup>a</sup>Transect A, 4500 ft brail run, main channel border, Iowa side.

Transect B, 4500 ft brail run, main channel, dredge site.

Transect C, 4500 ft brail run, main channel, dredge site.

Transect D, 4500 ft brail run, main channel border, Illinois side.

Transect E, 4500 ft brail run, nearshore, historic Illinois disposal site.

<sup>b</sup>Location F, hand collecting, nearshore, historic Illinois disposal site.

There were no mussel concentrations observed near the proposed dredge cut at the Albany Site which would be impacted adversely by future channel maintenance activity. Care should be taken, however, not to disturb the fauna in the area of Transect E, 100 feet from the Illinois shore disposal site. No endangered species were collected at this site during 1980, but in recent years L. higginsii has been collected repeatedly a short distance downstream. This species may be present in the assemblage along the Illinois shore at the Albany Site.

### 3.4.3 Steamboat Slough Site

The Steamboat Slough Site (RM 503-504) is located 9.9 miles upstream from Lock and Dam 14 and 18.4 miles downstream from Lock and Dam 13. This recurrent dredge site was dredged four times between 1961 and 1973 (USACOE 1974). Large volumes of spoil material have been removed from this area. On two occasions, 150,000 cubic yards of material were dredged. Brailing was conducted along Transects B, C, D, E and F in the main channel and channel border in the vicinity of the proposed cut (Figure 12).

In the past, the spoil has been placed along the east shore of the Iowa island and on the Illinois island. Locations K and I and Transect H at these two disposal sites were sampled by brailing and hand collecting (Figure 12). Future spoil may be placed in the deep water area west of the Illinois disposal island. This area has often been dredged commercially for sand and gravel. Mussels were sampled by brailing at Transect G in this area.

The main channel contained primarily fine sand substrates, and depths were relatively shallow, ranging from 11 to 13 feet. The upstream portion of the Iowa disposal site was a shallow (3 feet deep 100 feet from shore) sand bottom habitat. Depth increased to 6 feet in the downstream portions of the Iowa disposal site and substrates were primarily silty sand. The Illinois island disposal site was bordered by water 2 to 3 feet in depth on all but the western side, where depths reached 25 feet. In the shallow depths upstream from the Illinois island disposal site, a sandy substrate occurred and a silt-clay bottom was found along the eastern shore and the downstream tip of the island. The deep water area immediately west of the island contained a sand and gravel substrate. The western shore of the Illinois disposal island and the Iowa disposal area were predominantly sand and were frequently utilized for recreational activity. A commercial mussel bed was investigated near the Illinois shore (Location J) in a deep (approximately 12 feet) side channel habitat with a silty and sandy gravel substrate.

An extremely diverse and frequently abundant mussel assemblage was recorded in the Steamboat Slough Site in May and August 1980 (Table 10). Twenty-five species and 751 individuals were collected. Included in the collection were four live individuals of the Endangered species Lampsilis higginsii. Brail runs in the main channel and immediately outside of the main channel (Transects B through F) yielded few mussels, but specimens of Obovaria olivaria and Lampsilis ventricosa were collected along almost all transects.

Several mussels were collected by brailing 60 to 80 feet from the shore of the Iowa disposal area (Transect A). Further investigations of this disposal area by brailing, raking and pollywogging at Location K produced 301 individuals comprising 17 species. The mussels were concentrated primarily at the lower end of the spoil area. Mussels in this area did not occur in densities approaching those of a commercially valuable mussel bed. A single L. higginsii was collected along the Iowa disposal area by brailing near RM 503.6 approximately 60 to 80 feet from shore in 6 to 8 feet of water. Pollywogging in the same area produced numerous Amblema peruviana, Quadrula pustulosa and Quadrula quadrula, but no additional individuals of Higgins Eye were collected. Only one live Corbicula was collected; however, valves of several specimens, appearing to have died recently, were observed along the Iowa shoreline. Carunculina parva and Anodonta imbecillis were found in silty substrates of the slough on the Iowa disposal island.

Sampling near the Illinois disposal island by brailing (Transects G and H) and hand collecting (Location I) yielded numerous mussel species and individuals. Brailing along the western shore of the Illinois island yielded sparse numbers of mussels; however, among the collection were relic valves of a female L. higginsii and live juveniles of three other species. Few mussels were collected by brailing along the eastern side of the island. Pollywogging in the mixed silt, clay and sand substrate along the eastern shoreline of the disposal site produced numerous mussels, especially A. peruviana and Q. pustulosa. The valves of a young L. higginsii which apparently had died recently, were found along the west shoreline of the island. In addition, the only individual of Lampsilis anodontoides fallaciosa observed in this entire study was collected at this site. Mussels were also common in the shallow, hard-packed sand upstream from the disposal island. Live specimens of a female and a young male L. higginsii were observed approximately 300 feet northeast of the island. Quadrula nodulata, A. peruviana and Q. pustulosa were abundant in this upstream area.

Fifteen species were recorded from the mussel bed near the Illinois shore (Location J). A live female L. higginsii was collected on a brail run at this location. Numerous relic valves of this Endangered species were also observed along the Illinois shoreline near this bed. Megaloniais gigantea, Plagiola lineolata and Ligumia recta latissima, typical mussel bed species, also occurred at this location.

The bed along the Illinois shore (near Location J) was also surveyed during 1976 and 1977 (Lewis and Brice 1977; Lewis 1979). A total of 19 species were collected from this site by brailing and diving and included a specimen of the uncommon Strophitus undulatus. No Endangered or other special status species were reported from this bed. The mussel fauna upstream from the Steamboat Slough Site at RM 504.6 was also investigated during these 1976 and 1977 studies. Nine specimens of the Endangered L. higginsii were reported at this site along the Illinois shore. Freitag (USFWS 1980) also observed a dead specimen of a young male of this species near the Illinois island disposal site at RM 503.5 during 1979. Downstream from the dredge site (RM502.5), a commercial bed along the Iowa shore was brailed and yielded 11 species, including S. undulatus (Perry 1979). Strophitus undulatus was not collected in the present survey. No Endangered or special status species were reported by Perry.



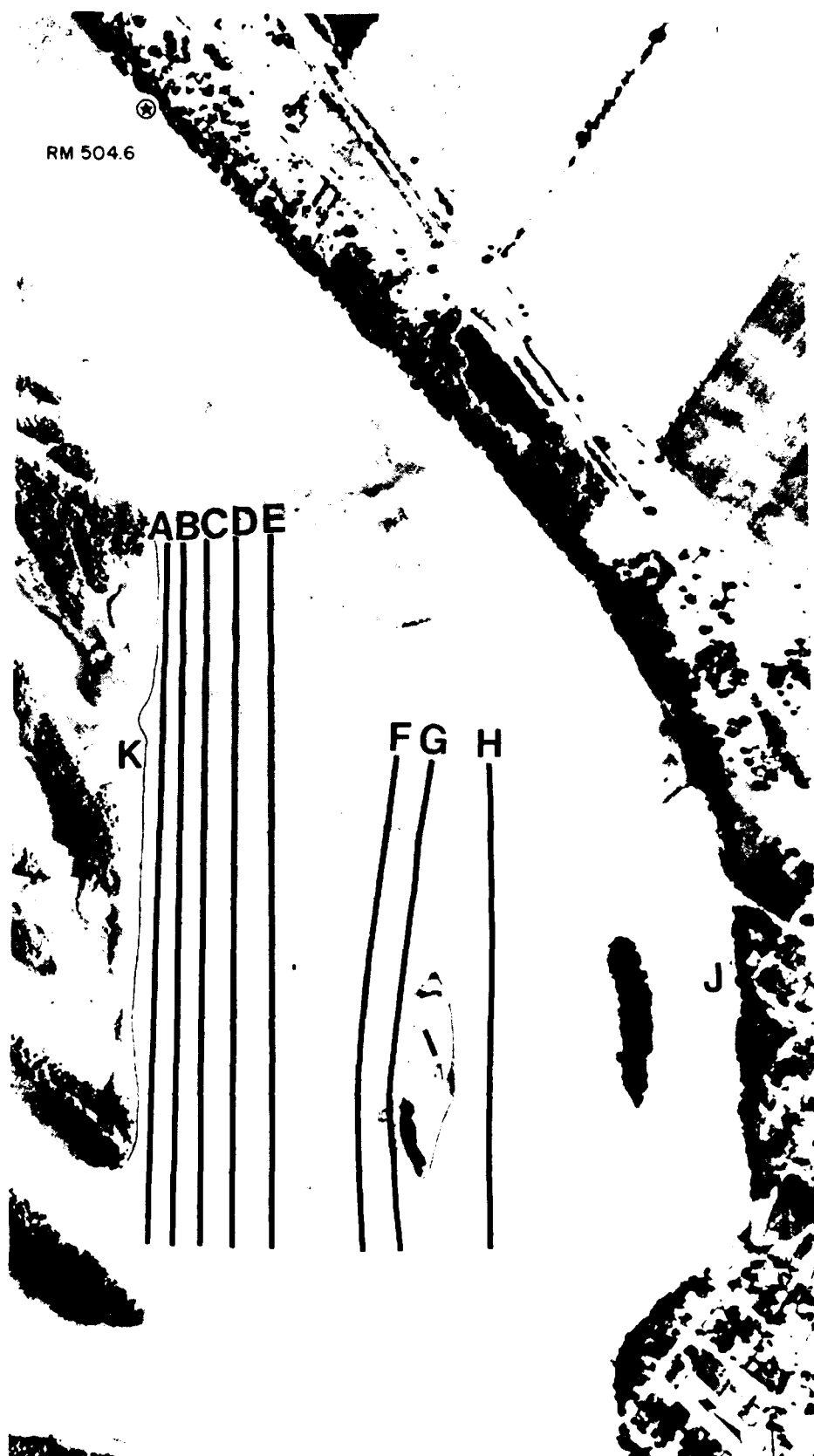


Figure 12. Collection locations near the Steamboat Slough Site in Pool 14 of the Mississippi River (RM 503.2-504.1), May and August 1980.

Table 10. Freshwater mussels collected near the Stearboat Slough Site in Pool 14 of the Mississippi River (RM 503.2-504.1), May and August 1980.

Organism	Brail Transect <sup>a</sup>								Other <sup>b</sup>			Total Mussels
	A	B	C	D	E	F	G	H	I	J	K	
CORBICULIDAE												
CORBICULA FLUMINEA	0	0	0	0	0	0	0	0	0	0	1	1
UNIONIDAE												
AMBLEMIDAE												
AMBLEMA PERUVIANA	13	2	0	0	1	0	4	1	127	20	139	307
FUSCONAIA UNDATA	3	1	0	0	0	0	0	0	5	5	14	28
MEGALONAIAS GIGANTEA	0	0	0	0	0	0	0	0	0	13	0	13
QUADRULA METANEVRA	0	0	0	0	0	0	0	0	2	1	0	3
Q. NODULATA	0	0	0	0	0	0	0	1	31	6	11	49
Q. PUSTULOSA	12	3	0	0	4	2	4	2	47	13	59	146
Q. QUADRULA	2	1	0	0	1	0	1	0	1	0	24	30
UNIONINAE												
ANODONTA CORPULENTA	1	0	0	0	0	0	0	0	2	0	2	5
A. IMBECILLIS	0	0	0	0	0	0	0	0	0	0	3	3
ARCIDENS CONFRAGOSUS	0	0	0	0	0	0	1	0	0	0	0	1
CARUNCULINA PARVA	0	0	0	0	0	0	0	0	0	0	4	4
LAMPSILIS ANODONTOIDES												
FALLACIOSA	0	0	0	0	0	0	0	0	1	0	0	1
L. HIGGINSII	0	0	0	0	0	0	0	0	2	1	1	4
L. VENTRICOSA	1	1	1	1	0	2	7	2	12	4	1	32
LASMIGONA COMPLANATA	0	0	0	0	0	0	0	0	1	0	0	1
LEPTODEA FRAGILIS	0	0	0	0	0	0	2	1	1	1	3	8
L. FRAGILIS JUV.	0	0	0	0	0	0	2	0	4	0	0	6
L. LAEVISSIMA	0	0	0	0	0	0	0	0	2	0	16	18
LIGUMIA RECTA LATISSIMA	0	0	0	0	0	0	0	0	0	1	0	1
OBLIQUARIA REFLEXA	1	0	0	0	1	0	1	2	17	1	14	37
OBOVARIA OLIVARIA	0	1	1	1	1	4	3	0	7	1	0	19
O. OLIVARIA JUV.	0	0	0	0	0	0	2	0	0	0	0	2
PLAGIOLA LINEOLATA	0	0	0	0	0	0	0	0	1	5	0	6
PROPTERA ALATA	0	0	0	0	0	0	0	0	1	1	2	4
TRUNCILLA DONACIFORMIS	2	0	0	0	0	0	1	0	2	0	6	11
T. DONACIFORMIS JUV.	0	0	0	0	0	0	3	0	4	0	0	7
T. TRUNCATA	0	0	0	0	0	0	0	0	2	1	1	4
TOTAL IN EACH SAMPLE	35	9	2	2	8	8	31	9	272	74	301	751

<sup>a</sup>Transect A, 4000 ft brail run, nearshore, historic Iowa disposal site.

Transect B, 4000 ft brail run, main channel border, Iowa side.

Transect C, 4000 ft brail run, main channel border, Iowa side.

Transect D, 4000 ft brail run, main channel, dredge site.

Transect E, 4000 ft brail run, main channel, dredge site.

Transect F, 3000 ft brail run, main channel border, Illinois side.

Transect G, brail runs, total of 6000 ft, nearshore, west side of historic and potential Illinois disposal site.

Transect H, 3000 ft brail run, nearshore, east side of historic and potential Illinois disposal site.

<sup>b</sup>Location I, hand collecting and brail, nearshore, Illinois disposal site.

Location J, hand collecting and brail, side channel, Illinois side, exploratory site.

Location K, hand collecting and brail, nearshore, historic Iowa disposal site.

The Steamboat Slough Site is a sensitive area relative to future channel maintenance owing to the widespread presence of L. higginsii. This site and the nearby upstream area appear to be one of the few areas in the Mississippi River where reproduction and recruitment of this species is occurring. Because of the Higgins' Eye in this section of the river, Havlik (1980) suggested that this general area is a prime candidate for critical habitat designation. Dredging activity in the main channel probably will affect few mussels; however, L. higginsii was present at both proposed disposal sites. Care must be taken not to disturb this species at either site. Future dredge material should be placed in the deep water along the west shore of the Illinois disposal area to avoid influencing this Endangered species or the other mussel assemblages in this area.

The Rock Island District has proposed that the Iowa disposal site no longer be used and that dredged material will be disposed on the Illinois island presently used. However, the landward side of this island will be diked to prevent flow of water into this area where L. higginsii may live. The above stipulations for the protection of L. higginsii were reviewed by the Fish and Wildlife Service under Section 7 of the Endangered Species Act (formal consultation with the Rock Island District) and concurred with.

### 3.5 POOL 15

#### 3.5.1 Winnebago Island Site

Winnebago Island Site (RM 489-490) was the only potential dredge site surveyed for mussels in Pool 15. The site is located near East Moline, Illinois, in the upper portion of the pool, 3.0 miles downstream of Lock and Dam 14. Dredging was conducted four times between 1945 and 1952 (USACOE 1974). The volume of material removed from this area was relatively small (<40,000 cubic yards) in each maintenance operation. The riverbed of Pool 15 is bedrock that required blasting and excavation to form the navigation channel. This is the only pool within the Rock Island District with a channel in bedrock and probably accounts for the stability of the navigation channel and infrequent need for maintenance dredging. The potential dredge cut was surveyed for mussels by brailing (3,500-ft runs) along Transects C, D, and E (Figure 13).

In past maintenance operations, dredge spoil has been placed in open water sites in Iowa and Illinois waters. Transects A and B (1,000-ft brailing runs) were established to survey mussels in the Iowa open water disposal site and Transects G and H (2,000-ft runs) were sampled at the Illinois open water disposal site. Winnebago Island, immediately adjacent to the proposed dredge cut, has also been utilized for spoil disposal, and is considered a potential site for placement of future spoil. Winnebago Island and its adjacent waters were intensively sampled by a combination of brailing and hand collecting at Transect F and Locations I, J and K (Figure 13). Exploratory brailing and hand collecting were conducted in the side channel near Campbell's Island at Location L (Figure 13).

The main channel along Transect D and E was 11- to 14-feet deep and contained a mixed rubble and sand substrate. The subsurface current velocity in the August sampling was 2.0 ft/sec. Numerous snags were present in the

rubble and sand substrate along the Iowa main channel border (Transect C) and the Iowa open water disposal site (Transects A and B). The Illinois main channel border areas along Transect F and the open water disposal area were characterized by fine to medium sand substrates and depths ranging from 7 to 11 feet. The upstream end of Winnebago Island at Location J and I was primarily silty sand. The side channel between Campbell's Island and the Illinois Shore (Location L) had a silt and clay substrate with maximum depths ranging from 5 to 10 feet.

The August 1979 survey of the Winnebago Island Site yielded 19 species totaling 392 individuals (Table 11). No Endangered or special status species were collected. Mussels were infrequently collected in the main channel and channel border areas near the potential dredge cut (Transects C through F). Quadrula pustulosa and Amblema peruviana were the only commonly collected species in these habitats. A relatively abundant (although not diverse) mussel fauna was present in the open water disposal sites in Iowa and Illinois waters (35 and 51 total individuals respectively). The dominant species in these areas were Q. pustulosa and Quadrula nodulata. Lampsilis ventricosa was also common in the Illinois disposal site.

A diverse and abundant mussel assemblage was represented in the brail and hand collections near Winnebago Island. Fourteen species, representing 173 individuals, were collected (primarily by brailing) along the upstream rocky shorelines of this island (Location I and J). Amblema peruviana composed over 50% of the total. Individuals of Actinonaias carinata and Quadrula metanevra were included in this assemblage. The silty sand substrate, downstream from Winnebago Island (Location K), also yielded numerous mussels, especially A. peruviana (Table 11). Exploratory sampling in the side channel near Campbell's Island (Location L) resulted in few mussels; however, the collection of Anodonta corpulenta represented an addition to the species list recorded for this site.

Many recent surveys have been conducted in Pool 15, but none have occurred near the Winnebago Island Site. During 1975, Helms investigated an area upstream from the present site at RM 492.0 (Perry 1979). Seventeen species were recorded, including the uncommon Elliptio dilatatus. Downstream from the site, extensive mussel surveys and relocation efforts were performed in a commercially valuable mussel bed near the Arsenal Island bridge at the upstream end of Sylvan Slough (RM 485.5). A preliminary survey of the bed in 1977 revealed 23 species, including single specimens of the Endangered Lampsilis higginsii, the special status species Cumberlandia monodonta, and the only modern record of Lasmigona compressa in the Mississippi River (Ecological Consultants, Inc. 1977). Freshwater mussels were relocated from areas of this bed which would be impacted by demolition and construction. In 1978, NUS Corp. (1979) removed a total of 7,096 individuals among 25 species, including three L. higginsii and 16 C. monodonta. Diving and brail collections during 1980 at the same site (Ecological Analysts, Inc. 1981a) yielded a total of 9,586 mussels of 26 species. Included in the collection were four L. higginsii and 12 C. monodonta. An additional mussel survey was conducted during 1979 in Sylvan Slough and along the Illinois shore upstream to RM 488.3 (Nelson 1979). Nineteen species, totaling 359 individuals, were collected; however, no Endangered or other special status species were recorded in this study.

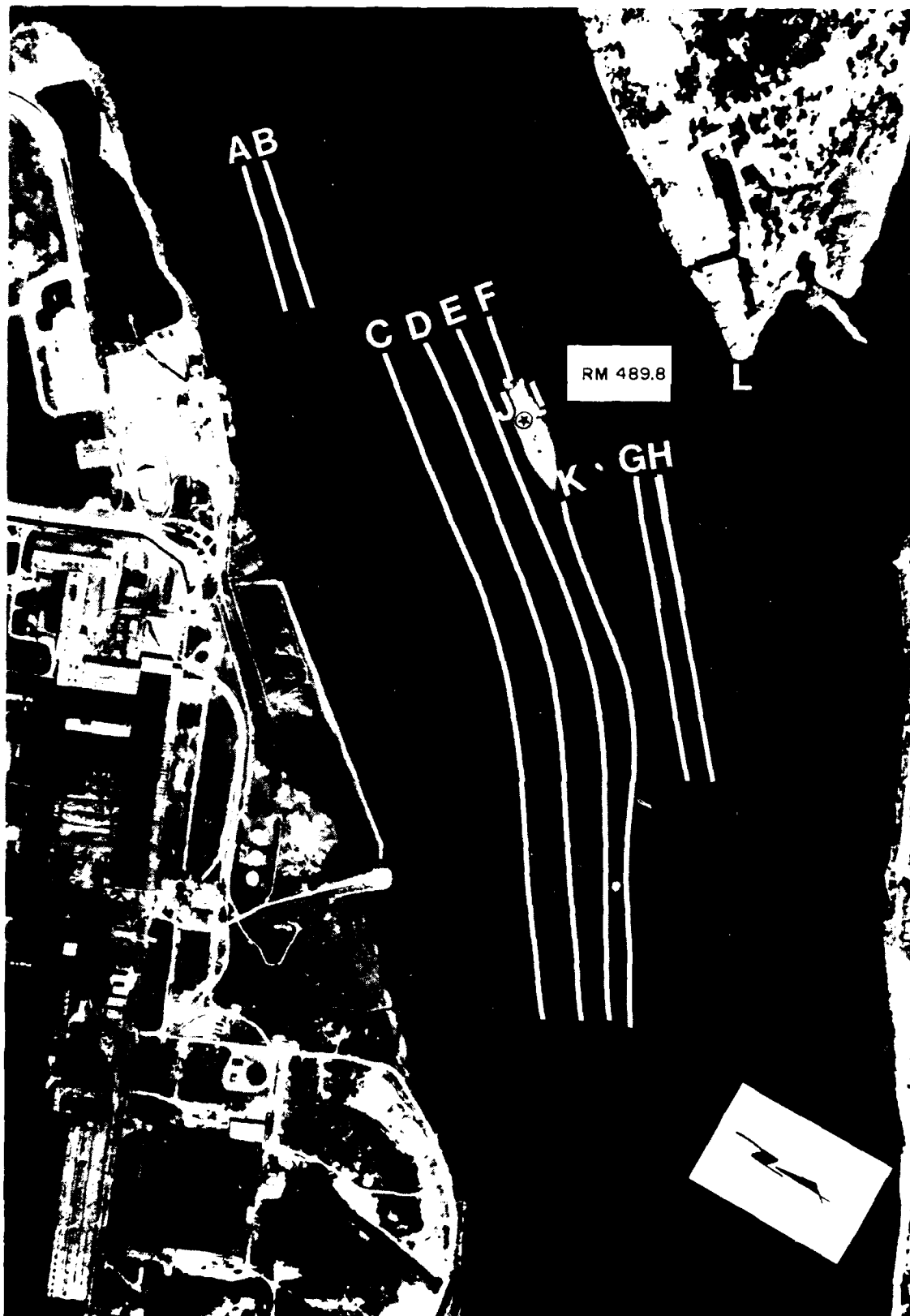


Figure 13. Collection locations near the Winnebago Island Site in Pool 15 of the Mississippi River (RM 489.3-490.2), August 1979.

Table 11. Freshwater mussels collected near the Winnebago Island Site in Pool 15 of the Mississippi River (RM 489.3-490.2), August 1979.

Organism	Brail Transect <sup>a</sup>								Other <sup>b</sup>				Total Mussels
	A	B	C	D	E	F	G	H	I	J	K	L	
CORBICULIDAE													
CORBICULA FLUMINEA	0	0	0	0	0	0	0	0	0	0	1	0	1
UNIONIDAE													
AMBLEMINEAE													
AMBLEMA PERUVIANA	2	2	3	3	0	1	0	0	67	43	55	1	177
FUSCONAIA UNDATA	0	0	0	0	0	0	0	0	2	0	5	1	8
MEGALONAIAS GIGANTEA	0	0	0	0	0	0	0	0	8	7	0	1	16
QUADRULA METANEVRA	0	0	0	0	0	0	0	1	0	1	0	0	2
Q. NODULATA	5	4	0	1	0	0	10	2	0	0	0	0	22
Q. PUSTULOSA	11	7	4	4	2	1	13	7	5	3	18	1	76
Q. QUADRULA	0	0	2	0	0	0	0	0	3	2	3	0	10
UNIONINAE													
ACTINONAIAS CARINATA	0	0	0	0	0	0	0	0	2	1	0	0	3
ANODONTA CORPULENTA	0	0	0	0	0	0	0	0	0	0	0	1	1
LAMPSILIS VENTRICOSA	3	0	0	2	0	0	5	6	6	5	9	0	36
LEPTODEA FRAGILIS	0	0	0	0	0	0	0	0	0	2	0	1	3
L. LAEVISSIMA	0	0	0	0	0	0	1	0	0	0	2	0	3
LIGUMIA RECTA LATISSIMA	0	0	0	0	0	1	0	0	4	2	1	0	8
OBLIQUARIA REFLEXA	0	0	1	0	0	1	1	0	0	1	0	0	4
OBOVARIA OLIVARIA	0	1	1	0	0	0	2	3	2	1	0	0	10
PLAGIOLA LINEOLATA	0	0	0	0	0	0	0	0	1	0	0	0	1
PROPTERA ALATA	0	0	0	0	0	0	0	0	5	0	3	1	9
P. ALATA JUV.	0	0	0	0	0	0	0	0	0	0	0	1	1
TRUNCILLA TRUNCATA	0	0	0	0	0	0	0	0	0	0	1	0	1
TOTAL IN EACH SAMPLE	21	14	11	10	2	4	32	19	105	68	98	8	392

<sup>a</sup>Transect A, 1000 ft brail run, main channel border, Iowa side, historic disposal site.

Transect B, 1000 ft brail run, main channel border, Iowa side, historic disposal site.

Transect C, 3500 ft brail run, main channel border, Iowa side, dredge site.

Transect D, 3500 ft brail run, main channel, dredge site.

Transect E, 3500 ft brail run, main channel, dredge site.

Transect F, 3000 ft brail run, main channel border, Illinois side.

Transect G, 2000 ft brail run, main channel border, Illinois side, historic disposal site.

Transect H, 2000 ft brail run, main channel border, Illinois side, historic disposal site.

<sup>b</sup>Location I, hand collecting and brail run, nearshore, east side of Winnebago Island, historic and potential disposal site.

Location J, hand collecting and brail run, nearshore, west side of Winnebago Island, historic and potential disposal site.

Location K, hand collecting, nearshore, south side of Winnebago Island, historic and potential disposal site.

Location L, hand collecting and brail run, slough, south side of Campbell's Island, exploratory site.

The paucity of mussels in the main channel of the Winnebago Island Site suggested that few mussels would be influenced by future dredge cuts in this area. However, the diverse and relatively abundant mussel fauna along the upstream shores of the Winnebago Island disposal area should be protected from any dredge spoil encroachment. There were no Endangered or special status species observed at this site in 1980. Populations of L. higginsii and C. monodonta have been reported about four miles downstream from the Winnebago Island Site, but probably will not be influenced by future channel maintenance activity in this area.

### 3.6 POOL 16

Mussels were surveyed at four channel maintenance dredging sites in Pool 16. The Lock and Dam 15 Lower Approach Site (RM 482) was located in the uppermost portion of Pool 16 extending from the Lock 15 guide walls, downstream nearly one mile. Centennial Bridge Site was located immediately downstream of the Lock and Dam 15 Lower Approach Site at RM 481-482. Dredging of these two proximal sites has occasionally been conducted as a single maintenance operation. The third area surveyed, Buffalo Towhead Site, was located in the middle stretch of Pool 16 near Buffalo, Iowa, at RM 472-473. The final area surveyed in Pool 16 was the Hershey Chute Site (RM 460-461) in the lower end of Pool 16 near Fairport, Iowa.

#### 3.6.1 Lock and Dam 15 Lower Approach Site

The Lock and Dam 15 Lower Approach was dredged six times between 1945 and 1973. Dredge volume has generally been small at this site. The largest volume of material removed was 34,000 cubic yards (USACOE 1974). Transects A, B, C, D and E (2,500 to 3,500-ft trail runs) were established to survey mussels in the vicinity of the potential dredge cut (Figure 14). Historically, spoil has been placed on the southern end of Arsenal Island, an area that will be used for disposal in the future also. Brailing Transect F in Sylvan Slough and Location G in the Arsenal Island wetland pond were surveyed for mussels in the vicinity of this disposal site.

A variety of substrates were encountered at this dredge site. The western portion of the main channel and main channel border were predominantly medium sand with areas of silty sand. The main channel and channel border area on the Illinois side ranged from rubble and sand near the lock to primarily sand with minor amounts of rubble in the downstream areas. The substrate in Sylvan Slough near the Arsenal Island disposal site was predominantly silty sand with occasional gravel. The wetland pond at this disposal site is isolated from the main stem of the Mississippi River during flat pool levels and contained a silty substrate. Depth in the main channel ranged from 9 to 13 feet at flat pool. In Sylvan Slough along the disposal site, depth was approximately 5 to 6 feet.

A total of 21 freshwater mussel species totaling 377 individuals were collected at the Lock and Dam 15 Lower Approach Site during August 1979 (Table 12). Main channel and main channel border trail runs (Figure 14, Transects A, B, C, D and E) yielded only five taxa and a total of 10 individuals. Quadrula pustulosa was the principal species in this sparse assemblage. One specimen of the uncommon Actinonaias carinata was collected near

the downstream end of this site in the Illinois main channel border area (Transect E). Numerous sub-fossil shells observed along the shore of the Arsenal Island historic disposal suggest the main channel may have been densely populated in the past.

Nearshore brailing in Sylvan Slough along the Arsenal Island disposal area yielded 333 individuals representing 17 taxa. One brail run of approximately 750 feet along the southern tip of Arsenal Island, 130 feet from shore, produced 127 individuals. Amblema peruviana was the most abundant species encountered in Sylvan Slough. Other dominant taxa collected from this brailing included Q. pustulosa, Plagiola lineolata, Obovaria olivaria, Proptera alata and Obliquaria reflexa. Three individuals of both Quadrula metanevra and A. carinata were also collected by brailing in this portion of Sylvan Slough.

The pond on Arsenal Island contained a mussel assemblage that differed greatly from the other areas examined at this site. Anodonta corpulenta was the most abundant mussel of the eight taxa collected by raking and pollywogging. This pond appeared to be an area of recruitment for several uncommon Mississippi River species. It was one of the few areas in the present survey where young specimens of Arcidens confragosus (<30 mm in length) and Lasmigona complanata (<70 mm in length) were collected. In addition, the only specimen of Anodonta suborbiculata found in this 1979-1980 survey was collected from this pond on Arsenal Island. This was a young specimen that was apparently a recent muskrat kill. Until 1977, when Havlik (1979) reported A. suborbiculata from Pool 8, Rock Island, Illinois, was believed to be the northern extent of the range of this species in the Mississippi River.

No recent historical data is available on the mussel fauna of the Mississippi River at the Lock and Dam 15 Lower Approach Site. Freitag (1978), in a survey of lower Sylvan Slough, collected nine taxa from one brailing run. All the taxa collected by Freitag were observed in the present study except Cumberlandia monodonta, a species under Notice of Review. Freitag (1978) also reported collecting a live female of the Endangered Lampsilis higginsii near the Sylvan Slough highway bridge abutment in a muskrat midden. A 1977 survey by Perry (1979) in lower Sylvan Slough yielded no freshwater mussels. Perry made three brailing runs at 25, 50- and 100-ft distances from the Arsenal Island shore. This was just inshore from the area in which large numbers of mussels were encountered in the present study.

Channel maintenance dredging probably will have little effect upon the mussel populations in the lower approach area to Lock and Dam 15. There appears to be very few mussels in the main channel at this site. Care should be taken, however, to keep the dredge spoil as far from the pond on Arsenal Island as possible. Spoils should be placed near the downstream tip of the island and along the Mississippi River shore of Arsenal Island to prevent any runoff from entering the pond or Sylvan Slough.

### 3.6.2 Centennial Bridge Site

The Centennial Bridge Site (RM 481-482) is located in the upper reach of Pool 16 between Rock Island, Illinois, and Davenport, Iowa. Channel maintenance dredging was conducted on two occasions at this site from 1945 through





Figure 14. Collection locations near the Lock and Dam 15 Lower Approach Site in Pool 16 of the Mississippi River (RM 482.1-482.9), August 1979.

Table 12. Freshwater mussels collected near the Lock and Dam 15 Lower Approach Site in Pool 16 of the Mississippi River (RM 482.1-482.9), August 1979.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINEAE								
AMBLEMA PERUVIANA	1	0	0	0	0	113	0	114
FUSCONAIA UNDATA	0	0	0	0	0	2	0	2
MEGALONAIAS GIGANTEA	0	0	0	0	0	4	0	4
QUADRULA METANEVRA	0	0	0	0	0	3	0	3
Q. PUSTULOSA	1	3	0	0	2	70	0	76
Q. QUADRULA	0	0	0	0	0	3	0	3
UNIONINAE								
ACTINONAIAS CARINATA	0	0	0	0	1	3	0	4
ANODONTA CORPULENTA	0	0	0	0	0	2	16	18
A. SUBORBICULATA	0	0	0	0	0	0	1	1
ARCIDENS CONFRAGOSUS	0	0	0	0	0	0	3	3
CARUNCULINA PARVA	0	0	0	0	0	0	1	1
LAMPSILIS VENTRICOSA	0	0	0	0	0	1	0	1
LASMIGONA COMPLANATA	0	0	0	0	0	1	2	3
LEPTODEA FRAGILIS	0	0	0	0	0	8	4	12
L. FRAGILIS JUV.	0	0	0	0	0	3	0	3
L. LAEVISSIMA	0	0	0	0	0	0	4	4
LIGUMIA RECTA LATISSIMA	0	1	0	0	0	1	0	2
OBLIQUARIA REFLEXA	0	0	0	0	0	12	0	12
OBOVARIA OLIVARIA	1	0	0	0	0	25	0	26
PLAGIOLA LINEOLATA	0	0	0	0	0	55	0	55
PROPTERA ALATA	0	0	0	0	0	23	0	23
TRUNCILLA DONACIFORMIS	0	0	0	0	0	4	3	7
TOTAL IN EACH SAMPLE	3	4	0	0	3	333	34	377

<sup>a</sup>Transect A, 3000 ft brail run, main channel border, Iowa side.

Transect B, 3500 ft brail run, main channel, dredge site.

Transect C, 3500 ft brail run, main channel, dredge site.

Transect D, 3500 ft brail run, main channel, dredge site.

Transect E, 2500 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, brail runs, nearshore, east side of Arsenal Island, Sylvan Slough, historic and potential disposal site.

Location G, hand collecting, Arsenal Island pond, historic and potential disposal site.

1973 (USACOE 1974). The Centennial Bridge Site is adjacent to the Lock and Dam 15 Lower Approach Site and channel dredging was occasionally conducted as a continuous operation from one site into the next. Brail Transects B through E (Figure 15) were established to assess the mussel fauna of the main channel and Illinois channel border. Future dredging at the Centennial Bridge Site will occur on the Illinois side of the main channel.

Historic spoil disposal areas at this site are located along the Iowa channel border in open water and along the Illinois shoreline. Future spoil probably will be placed along the Illinois shoreline. Mussels near the Illinois disposal were sampled by brailing (Transects F and G) and by hand collecting (Location H). Brail Transect A was established to survey the fauna of the Iowa historic disposal site.

Channel maintenance dredging at the Centennial Bridge Site historically has been a sensitive issue for the USACOE. A known mussel bed is located between the dredge cut area in the main channel and the Illinois shoreline spoil disposal area (R.M. Baker, USACOE, personal communication, 20 August 1979).

Substrates in the main channel in the present survey were primarily medium grain sand with lesser amounts of gravel and rubble. Channel depth at flat pool varied from 12 to 14 feet, and the current velocity varied from 2.3 to 2.5 ft/sec in the September sampling. The Iowa and Illinois channel border areas had predominantly rubble substrates with small amounts of sand and gravel. The Illinois disposal shoreline had large areas of sandy rubble interspersed with occasional pockets of silt.

Brail collections were conducted at the Centennial Bridge Site in August 1979 during a period of unusually high and turbid river flow. Because of the difficult sampling conditions, the site was resurveyed during low river flow in September 1979. The brailing results were surprisingly similar. Thirteen species representing a total of 93 mussels were brailed at Transects B through G in August (Table 13) and 97 individuals representing 12 species were collected from the same transects in September (Table 14). The August and September samplings combined yielded 19 species and 260 individuals. No Endangered or special status species were observed at this site.

Brail runs in the channel (Transects B, C and D) yielded a combined total of only three mussels in August and September, whereas numerous mussels were encountered in the Illinois channel border habitat (Transects E, F and G). Amblema peruviana, Quadrula pustulosa and Obovaria olivaria were the dominant species in these two samplings. Proptera alata was also commonly collected in September. In both surveys, the greatest densities were recorded along Transect F, approximately 160 to 225 feet from the shore of the Illinois disposal site. This assemblage, while abundant, differed from a typical commercial bed of the Mississippi River. The densities along Transect F (maximum of 13 individuals/500-ft run) were much lower than densities recorded in the comparison beds at Big Timbers (average of 54 mussels/500-ft run) and New Boston (average of 31 mussels/500-ft run). In the September survey during low flow, the shoreline of the Illinois disposal site was sampled by pollywogging and raking. Numerous small mussels were collected, including juveniles of Anodonta imbecillis, Leptodea fragilis, Leptodea laevis, P. alata and Truncilla donaciformis. The most abundant species

along the shoreline was the Asiatic Clam, Corbicula fluminea. Two dead specimens of the special status species Cumberlandia monodonta were found at this disposal site. The Iowa historic disposal site was brailled in August 1979 (Transect A; Table 13). This channel border habitat yielded only four taxa and a total of 14 individuals. Amblema peruviana accounted for 10 of the 14 individuals.

The Centennial Bridge Site was surveyed for mussels in 1977 (Fuller 1978) and 1978 (Freitag 1978). Fuller (1978) reported 172 mussels among 18 species, and Freitag (1978) collected a total of 11 species and 130 individuals. The same species were dominant in the present survey, and in the 1977 and 1978 investigations of Fuller and Freitag. In 1978 and in the present survey, the greatest densities were present in the area of Transect F. Two species reported by Fuller (Lasmigona complanata and Quadrula metanevra) and one species reported by Freitag (Strophitus undulatus) were not observed in the present study. Dead shells of C. monodonta and the Endangered Lampsilis higginsii were observed at the Illinois shore disposal area by Fuller (1978). In 1975 and 1976, Perry (1979) made numerous collections at a commercial mussel bed downstream from this site at RM 478.3. He recorded 19 species, including the Endangered L. higginsii.

The dead shells of C. monodonta and L. higginsii at the historic Illinois disposal site may be an indication that these species are present in the adjacent Illinois channel border mussel assemblage. Caution should be taken during channel maintenance activity to protect this assemblage. The effects of USACOE activity will depend upon the width of the dredge cut and the disposal practices. Recommended mitigative measures include minimizing the width of the dredge cut, particularly along the Illinois shore, and utilizing disposal techniques that produce little or no sediment runoff and siltation.

### 3.6.3 Buffalo Towhead Site

The Buffalo Towhead Site includes a channel-maintenance area and a harbor-maintenance area. The channel-maintenance site at RM 472-473 near Buffalo, Iowa, has been dredged only three times during 1945-1973 (USACOE 1974). Brail Transects B, C, D and E (each 3500 feet) were established in the area of the proposed dredge cut to survey the channel and channel border mussel fauna (Figure 16). Historically, dredge spoil has been placed along the Iowa shoreline and on the Illinois island adjacent to the site. Brailing and hand collecting were performed at Transect A and Location F to assess the mussel assemblages of these areas.

The Andalusia Boat Harbor has been dredged on five occasions from 1967 through 1973 (USACOE 1974). The historic and potential future disposal site is located immediately west of the harbor. The area downstream from the site in Andalusia Slough was surveyed by brailing (Transects G and H) and diving (Location L). The fauna upstream from the site was sampled at Transects I and J, and Location K.

The main channel and channel border areas near the proposed dredge cut (Transects A through E) had a predominantly fine sand substrate. The downstream portion of Transect E, however, contained a sandy gravel bottom. Depth of the main channel varied from 10 to 16 feet. The Iowa and Illinois disposals had substrates composed primarily of fine sand.



Figure 15. Collection locations near the Centennial Bridge Site in Pool 16 of the Mississippi River (RM 481.3-482.1), August and September 1979.

Table 13. Freshwater mussels collected near the Centennial Bridge Site in Pool 16 of the Mississippi River (RM 481.3-482.1), August 1979.

Organism	Brail Transect <sup>a</sup>							Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINEAE								
AMBLEMA PERUVIANA	10	0	0	0	17	24	0	51
FUSCONAIA UNDATA	1	0	0	0	1	0	0	2
MEGALONAIAS GIGANTEA	0	0	0	0	1	2	0	3
QUADRULA PUSTULOSA	0	0	0	0	5	2	2	9
Q. QUADRULA	0	0	0	0	1	0	0	1
UNIONINAE								
ACTINONAIAS CARINATA	0	0	0	0	1	0	0	1
ARCIDENS CONFRAGOSUS	0	0	0	0	0	1	0	1
LAMPSILIS VENTRICOSA	0	0	1	0	1	3	1	6
LEPTODEA FRAGILIS	0	0	0	0	0	0	5	5
L. LAEVISSIMA	0	0	0	0	0	1	0	1
L. LAEVISSIMA JUV.	0	0	0	0	0	1	1	2
OBOVARIA OLIVARIA	2	0	0	0	4	8	1	15
PLAGIOLA LINEOLATA	0	0	0	1	0	1	0	2
PROPTERA ALATA	1	0	0	0	0	4	1	6
P. ALATA JUV.	0	0	0	0	0	0	2	2
TOTAL IN EACH SAMPLE	14	0	1	1	31	47	13	107

<sup>a</sup>Transect A, 1500 ft brail run, main channel border, Iowa side, historic disposal site.

Transect B, 1000 ft brail run, main channel, potential dredge site.

Transect C, 4500 ft brail run, main channel, dredge site.

Transect D, 3500 ft brail run, main channel, dredge site.

Transect E, 3500 ft brail run, main channel border, potential dredge site.

Transect F, 3500 ft brail run, main channel border, Illinois side.

Transect G, 2500 ft brail run, main channel border, Illinois side, historic and potential disposal site.

Table 14. Freshwater mussels collected near the Centennial Bridge Site in Pool 16 of the Mississippi River (RM 481.3-482.1), September 1979.

Organism	Brail Transect <sup>a</sup>							Other <sup>b</sup>	Total
	A	B	C	D	E	F	G	H	Mussels
CORBICULIDAE									
CORBICULA FLUMINEA	0	0	0	0	0	0	0	30	30
UNIONIDAE									
AMBLEMINAE									
AMBLEMA PERUVIANA	0	0	0	0	24	16	1	0	41
FUSCONAIA UNDATA	0	0	0	0	0	1	0	0	1
QUADRULA PUSTULOSA	0	0	0	0	3	10	5	0	18
Q. QUADRULA	0	0	0	0	0	3	2	0	5
UNIONINAE									
ANODONTA CORPULENTA	0	0	0	0	0	0	0	2	2
A. IMBECILLIS	0	0	0	0	0	0	0	1	1
A. IMBECILLIS JUV.	0	0	0	0	0	0	0	1	1
ARCIDENS CONFRAGOSUS	0	0	0	0	2	0	0	0	2
LAMPSILIS VENTRICOSA	0	0	0	0	0	1	2	0	3
LEPTODEA FRAGILIS	0	0	0	0	1	0	0	9	10
L. FRAGILIS JUV.	0	0	0	0	0	0	0	4	4
L. LAEVISSIMA	0	1	0	0	0	0	0	2	3
L. LAEVISSIMA JUV.	0	0	0	0	0	0	0	4	4
LIGUMIA RECTA LATISSIMA	0	0	0	0	0	0	1	0	1
OBOVARIA OLIVARIA	0	0	0	0	2	8	1	0	11
PROPTERA ALATA	0	0	0	0	3	5	4	1	13
P. ALATA JUV.	0	0	0	0	0	0	0	1	1
TRUNCILLA TRUNCATA	0	0	0	0	1	0	0	0	1
T. DONACIFORMIS JUV.	0	0	0	0	0	0	0	1	1
TOTAL IN EACH SAMPLE	0	1	0	0	36	44	16	56	153

<sup>a</sup>Transect A, not sampled in September.

Transect B, 1000 ft brail run, main channel, potential dredge site.

Transect C, 4500 ft brail run, main channel, dredge site.

Transect D, 3500 ft brail run, main channel, dredge site.

Transect E, 3500 ft brail run, main channel border, Illinois side, potential dredge site.

Transect F, 3500 ft brail run, main channel border, Illinois side.

Transect G, 3500 ft brail run, main channel border, Illinois side, historic and potential disposal site.

<sup>b</sup>Location H, hand collecting, nearshore, Illinois side, historic and potential disposal site.

The riverbed of Andalusia Slough was composed of variable mixtures of silt and sand with occasional small amounts of clay and gravel. Occasional outcroppings of bedrock were observed along the shoreline. Commercial mussel beds were located along Transects G, H, I and J (Kenneth Finley, commercial clammer, personal communication, 1979). The river depth at these beds ranged from 8 to 12 feet.

A total of 661 individuals representing 27 mussel species were collected at the Buffalo Towhead Site in August and September 1979 (Table 15). Only three mussels were collected in the main channel (Transects B, C and D). A relatively abundant fauna was observed at the upstream and downstream portions of Transect E in the Illinois channel border habitat. Two individuals of the rarely collected Plethobasus cyphus were recorded from this channel border mussel assemblage, which was dominated by Amblema peruviana, Obovaria olivaria and Quadrula pustulosa. The uncommon Strophitus undulatus was one of only three species brailed near the Iowa shoreline disposal (Transect A). Collections near the Illinois island disposal (Location F) yielded few mussels. The Asiatic Clam Corbicula fluminea, however, was collected by raking along the disposal shoreline.

Diverse and abundant mussel assemblages were observed in the present study upstream and downstream from Andalusia Boat Harbor in Andalusia Slough. Brailing and diver-sampling revealed a narrow seam of mussels downstream from Andalusia Harbor. This assemblage was diverse and occasionally very densely populated. The mussel fauna near the mouth of the harbor, however, was sparse. Obovaria olivaria and Q. pustulosa were the dominant species collected by brailing along Transects G and H. The greatest numbers (58 mussels/500-ft run) were taken in the downstream portion of Transect H approximately 150 feet from the Illinois shore. An individual of the special status species Cumberlandia monodonta was collected in this densely populated area. Quantitative diver-samples were collected along Transect H near this concentrated mussel assemblage (Location L). The quadrat samples revealed a patchy distribution of mussels and an average density of 32.7 mussels/m<sup>2</sup>.

Relatively large mussel densities also were observed at two mussel beds (Transects I and J) upstream from Andalusia Harbor. Brailing along Transect J averaged 38.0 mussels/500-ft run. Maximum density was 53 mussels/500-ft run. Individuals of the uncommon Lasmigona complanata and P. cyphus were present. Amblema peruviana, Fusconaia undata, Megalonaias gigantea and Actinonaias carinata (in decreasing order of abundance) were the most abundant species at Transect J. Diving in this area (Location K) revealed an average density of 61.3 mussels/m<sup>2</sup>. The dominant species in these quadrat samples were A. peruviana, F. undata and M. gigantea. Juveniles of Leptodea fragilis, Proptera alata and Truncilla donaciformis were also present in these samples. Brail and diver-sampling along Transect J revealed a mussel assemblage much more extensive and plentiful than the fauna downstream from Andalusia Harbor (Transects G and H) where it was sporadic.

The mussel bed along Transect I also yielded an abundant and diverse assemblage of mussels. A female Lampsilis higginsii was observed in the brail collections from this location. In addition, the only Pleurobema cordatum collected in this 1979-1980 survey occurred at Transect I. The uncommon



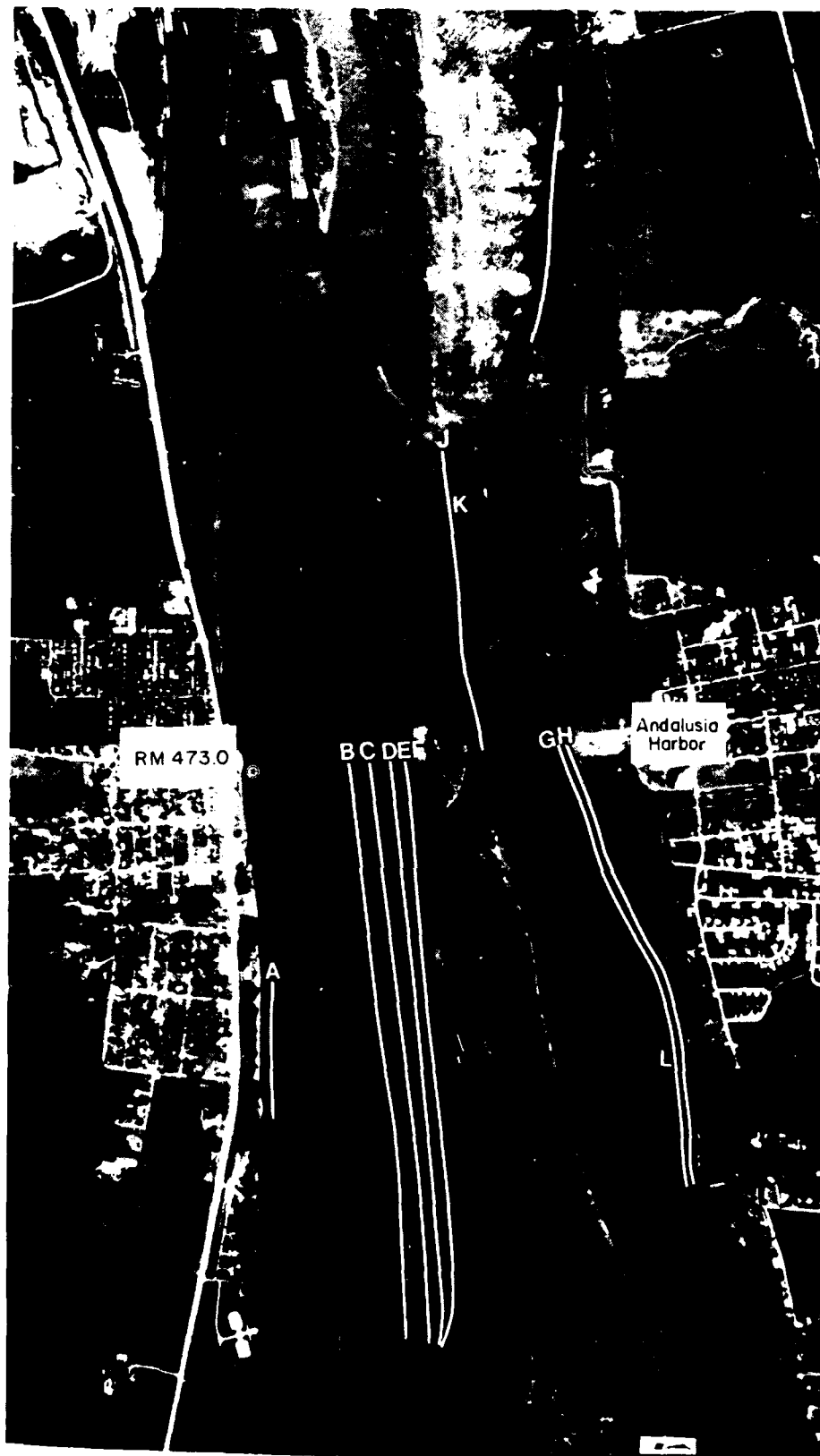


Figure 16. Collection locations near the Buffalo Towhead Site in Pool 16 of the Mississippi River (RM 472.0-473.1), August and September 1979.

Table 15. Freshwater mussels collected near the Buffalo Towhead Site in Pool 16 of the Mississippi River (RM 472.0-473.1), August and September 1979.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>	Brail Transect <sup>c</sup>					Other <sup>d</sup>		Total Mussels
	A	B	C	D	E		F	G	H	I	J	K	L	
CORBICULIDAE														
CORBICULA FLUMINEA	0	0	0	0	0	1	0	0	0	0	3	0	4	
MARGARITIFERIDAE														
CUMBERLANDIINAE														
CUMBERLANDIA MONODONTA	0	0	0	0	0	0	0	1	0	0	0	0	1	
UNIONIDAE														
AMBLEMINEAE														
AMBLEMA PERUVIANA	1	0	0	0	8	10	5	12	35	80	31	13	195	
FUSCONAIA UNDATA	0	0	0	0	2	0	0	2	13	33	16	5	71	
MEGALONAIAS GIGANTEA	0	0	0	0	0	0	0	4	13	15	12	7	51	
QUADRULA METANEVRA	0	0	0	0	3	0	2	2	0	2	0	0	9	
Q. NODULATA	0	0	0	0	0	1	2	1	0	0	0	0	4	
Q. PUSTULOSA	4	0	0	0	7	2	8	23	21	12	10	9	96	
Q. QUADRULA	0	0	0	0	1	0	1	9	12	3	2	7	35	
UNIONINAE														
ACTINONAIAS CARINATA	0	0	0	0	2	0	2	4	5	14	2	0	29	
ANODONTA CORPULENTA	0	0	0	0	0	0	0	4	0	1	0	0	5	
ARCIDENS CONFRAGOSUS	0	0	0	0	0	0	0	0	0	1	0	0	1	
LAMPSILIS HIGGINSII	0	0	0	0	0	0	0	0	1	0	0	0	1	
L. VENTRICOSA	0	1	1	0	3	0	2	9	4	7	1	0	28	
LASMIGONA COMPLANATA	0	0	0	0	0	0	0	0	1	2	0	0	3	
LEPTODEA FRAGILIS	0	0	0	0	0	2	2	0	2	0	7	3	16	
L. LAEVISSIMA	0	0	0	0	1	0	0	3	0	0	2	1	7	
LIGUMIA RECTA LATISSIMA	0	0	0	0	0	0	0	0	0	1	0	0	1	
OBLIQUARIA REFLEXA	0	0	0	0	0	0	0	2	5	1	1	0	9	
OBOVARIA OLIVARIA	0	0	1	0	8	0	9	20	11	6	1	1	57	
PLAGIOLA LINEOLATA	0	0	0	0	0	0	0	6	3	7	1	3	20	
PLETHOBASUS CYPHYUS	0	0	0	0	2	0	0	0	1	1	0	0	4	
PLEUROBEMA CORDATUM	0	0	0	0	0	0	0	0	1	0	0	0	1	
PROPTERA ALATA	0	0	0	0	0	0	0	2	2	3	1	0	8	
STROPHITUS UNDULATUS	1	0	0	0	0	0	0	0	1	0	0	0	2	
TRUNCILLA DONACIFORMIS	0	0	0	0	0	0	0	0	0	0	2	0	2	
T. TRUNCATA	0	0	0	0	0	0	0	0	0	1	0	0	1	
TOTAL IN EACH SAMPLE	6	1	2	0	37	16	33	104	131	190	92	49	661	

<sup>a</sup>Transect A, 1000 ft brail run, main channel border, Iowa side, historic disposal site.

Transect B, 3500 ft brail run, main channel, dredge site.

Transect C, 3500 ft brail run, main channel, dredge site.

Transect D, 3500 ft brail run, main channel, dredge site.

Transect E, 3500 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, brail run and hand collecting, main channel border, historic disposal site.

<sup>c</sup>Transect G, 3000 ft brail run, Andalusia Slough, historic disposal site.

Transect H, 3000 ft brail run, Andalusia Slough, historic disposal site.

Transect I, 2000 ft brail run, Andalusia Slough.

<sup>d</sup>Transect J, 2500 ft brail run, Andalusia Slough.

Location K, results of six 0.5 m<sup>2</sup> quadrat samples along Transect J, Andalusia Slough.

Location L, results of six 0.5 m<sup>2</sup> quadrat samples along Transect H, Andalusia Slough.

species L. complanata, P. cyphus and S. undulatus also were recorded from this bed. Amblema peruviana and Q. pustulosa were the most abundant species. Brail sampling along Transect I averaged 32.5 mussels/500-ft run, and a maximum of 52 mussels/500-ft run was collected.

The fauna of Andalusia Slough was found to be one of the most diverse areas sampled in this survey. The special status species L. higginsii and C. monodonta were present in this side channel habitat. In addition, several individuals of other uncommon Mississippi River species were collected. The presence of numerous juveniles suggested this was an area of recruitment. Havlik (1980) indicated that Andalusia Slough is a prime candidate for critical habitat designation.

The portion of the Mississippi River near the Buffalo Towhead Site was recently investigated by several researchers. A commercially harvested mussel bed at RM 477.6-478.3 was sampled in 1975-1976 (Perry 1979) and yielded 19 mussel species, including the Endangered L. higginsii. The area immediately upstream from this bed was surveyed in May 1979 (ERT, Inc. 1980). A total of 626 mussels among 10 species was reported; however, no special status species were observed. Nearly 75% of the mussels collected were A. peruviana. In 1975, Perry (1979) conducted several channel and channel border brail runs near the present site at RM 470.5, 471.6, 471.9 and 473.8. Only a few species were collected at each site, and no special status or uncommon species were reported.

Nelson and Freitag (1980) reported 26 species in collections from Andalusia Slough in 1979. Lampsilis higginsii was collected from the same mussel beds that were surveyed in the present survey (Transects H and I). In addition, the rarely collected species, Cyclonaias tuberculata and Tritogonia verrucosa, were reported. Perry (1979) also brailed at Andalusia Slough near RM 467.0 in 1975. He recorded only three species, all of which were collected in the present survey.

The channel dredge cut at the Buffalo Towhead Site will impact only a few mussels in the sparsely populated main channel. Care should be taken during dredging and spoil placement not to disturb the mussel fauna at the downstream end of Transect E.

A confined disposal must be provided to insure that dredging in Andalusia Boat Harbor will not have a drastic effect on the mussel assemblage of Andalusia Slough. Mussels were sparse near the mouth of the harbor; however, approximately 2,000 feet downstream, an abundant fauna was present. The special status species C. monodonta was present in this bed in the present survey and the Endangered L. higginsii was recently observed in this area. Spoil encroachment and excessive sedimentation should be avoided in future dredging at this harbor to ensure that this downstream fauna is not disturbed.

#### 3.6.4 Hershey Chute Site

The Hershey Chute Site is located in the Lower portion of Pool 16 about two miles south of Fairport, Iowa. This recent channel maintenance area near RM 461 has been dredged on three occasions since 1962 (USACOE 1974). The main channel and channel border were sampled along four brail transects (Transects B through E) to describe the mussel fauna in the area of the proposed dredge cut (Figure 17).

Historically, dredge spoil has been placed along the east banks of the two Iowa islands adjacent to the site. Spoil from future channel maintenance operations is expected to be deposited on the upstream island. A single 3,500-ft brail run (Transect A) and hand collections (near Location F) were conducted near the shore of the upstream island to assess the impact of future spoil disposal at this site.

The main channel had a uniform fine sand substrate and depths ranged from approximately 15 feet in the Illinois portion of the channel to 12 feet in the Iowa waters. Illinois channel border substrates varied from silty sand upstream to sandy gravel in the rip-rapped lower section. An extensive shallow area with mixed clay, silt and sand occurred downstream of the Iowa disposal area near Location F. The remainder of the Iowa channel border near this site was primarily fine sand.

A total of 17 species and 301 individuals were collected in the July 1980 survey of the Hershey Chute Site (Table 16). No special status species were recorded at this site. The fauna of the sandy main channel and Iowa channel border (Transects B, C and D) was sparse. Three individuals of Obovaria olivaria were the only mussels collected in this unstable, recently dredged area. Brailing in the Illinois channel border habitat revealed a relatively diverse and abundant mussel assemblage at the downstream section of Transect E. Nine species and a maximum density of 46 mussels per 500-ft brail run were recorded from this channel border habitat. Quadrula pustulosa, Amblema peruviana, Obovaria olivaria and Megalonaias gigantea (in decreasing order of abundance) were the dominant species in these brail collections.

Few mussels were collected by raking and pollywogging along the sandy shoreline of the Iowa disposal island; however, 198 individuals and 14 species were collected in the shallow area downstream from the island disposal (Location F). The most abundant mussels at this location were A. peruviana, Q. pustulosa and Fusconaia undata. A single individual of the uncommon Lasmigona complanata was also collected from this shallow channel border habitat. Brailing along the disposal site (Transect A) yielded eight juveniles of Leptodea laevis.

Only one mussel survey has been conducted near the Hershey Chute Site in recent years. Perry (1979) conducted a brail run in the main channel at RM 462.3 upstream from the site. He reported five species which were all common to the present study. In 1930-1931, Ellis surveyed an area of the Mississippi River immediately upstream of Fairport, Iowa, near RM 464 (van der Schalie and van der Schalie 1950). He collected 24 species, including individuals of the presently rare or Endangered species Proptera capax, Tritogonia verrucosa and Plethobasus cyphus. The predominant mussels in his collection were Q. pustulosa and O. olivaria.

The impact of the dredge cut at the Hershey Chute Site would be minimal. A sparse fauna was present in the main channel, and no special status species were present at this site. The productive area downstream from the disposal area, however, might be jeopardized by future spoil disposal. Disposal activity should be conducted cautiously to avoid spoil encroachment or excess sedimentation on this mussel fauna.

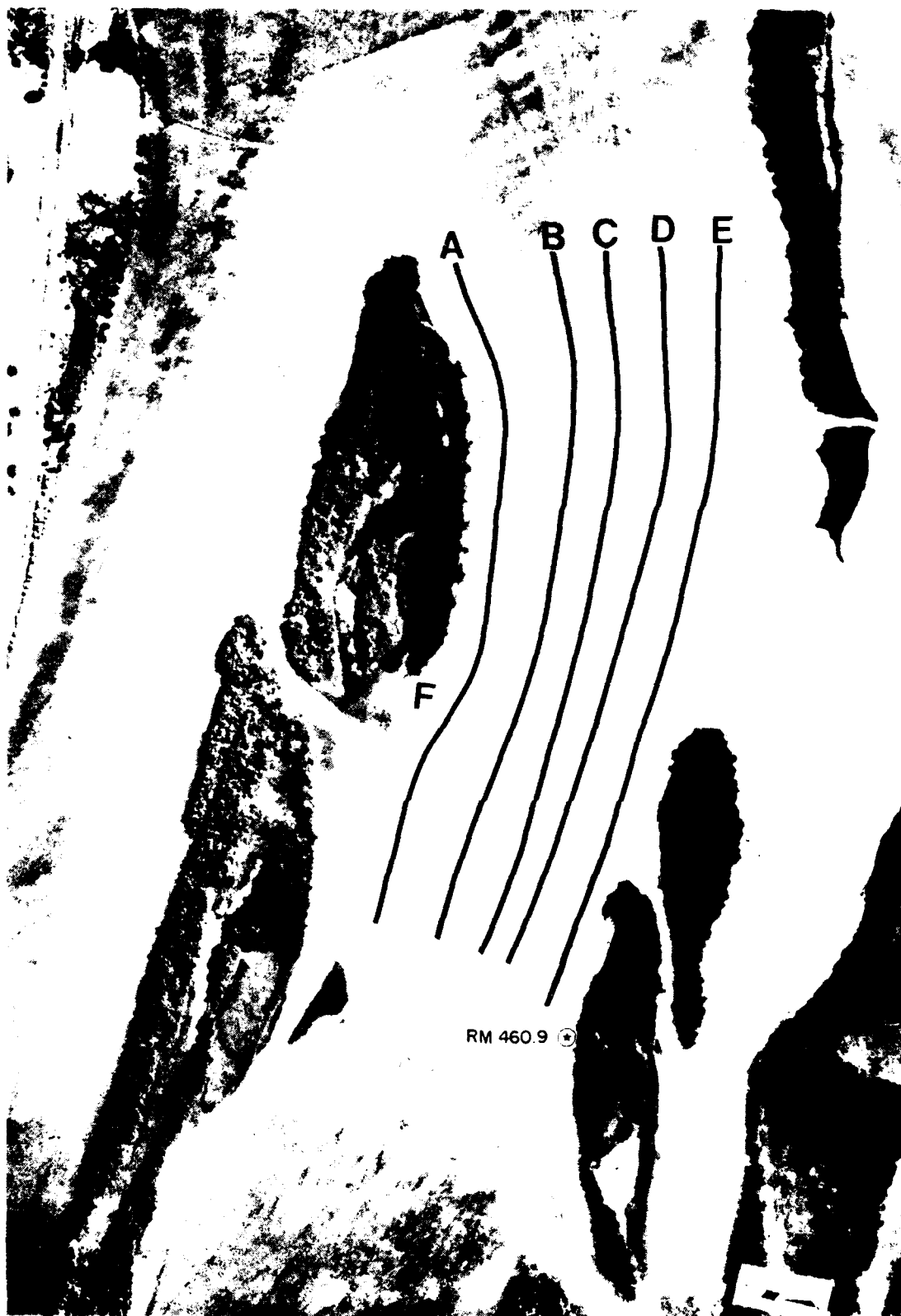


Figure 17. Collection locations near the Hershey Chute Site in Pool 16 of the Mississippi River (RM 460.9-461.7), July 1980.

Table 16. Freshwater mussels collected near the Hershey Chute Site in Pool 16 of the Mississippi River (RM 460.9-461.7), July 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	
CORBICULIDAE							
CORBICULA FLUMINEA	0	0	0	0	0	1	1
UNIONIDAE							
AMBLEMINAE							
AMBLEMA PERUVIANA	3	0	0	0	19	109	131
FUSCONAIA UNDATA	1	0	0	0	0	32	33
MEGALONAIAS GIGANTEA	0	0	0	0	10	0	10
QUADRULA NODULATA	0	0	0	0	3	3	6
Q. PUSTULOSA	2	0	0	0	26	40	68
Q. QUADRULA	0	0	0	0	1	1	2
UNIONINAE							
ANODONTA CORPULENTA	0	0	0	0	0	2	2
A. IMBECILLIS	0	0	0	0	0	1	1
LAMPSILIS VENTRICOSA	0	0	0	0	0	1	1
LASMIGONA COMPLANATA	0	0	0	0	0	1	1
LEPTODEA LAEVISSIMA	0	0	0	0	0	2	2
L. LAEVISSIMA JUV.	8	0	0	0	0	0	8
OBLIQUARIA REFLEXA	0	0	0	0	3	3	6
OBOVARIA OLIVARIA	1	2	1	0	18	0	22
O. OLIVARIA JUV.	0	0	0	0	1	0	1
PLAGIOLA LINEOLATA	0	0	0	0	2	0	2
PROPTERA ALATA	0	0	0	0	0	1	1
TRUNCILLA DONACIFORMIS	0	0	0	0	1	1	2
T. DONACIFORMES JUV.	1	0	0	0	0	0	1
TOTAL IN EACH SAMPLE	16	2	1	0	84	198	301

<sup>a</sup>Transect A, 3500 ft brail run, nearshore, historic and potential Iowa disposal site.

Transect B, 3500 ft brail run, main channel border, Iowa side.

Transect C, 3500 ft brail run, main channel, dredge site.

Transect D, 3500 ft brail run, main channel, dredge site.

Transect E, 4000 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, hand collecting, nearshore, historic and potential Iowa disposal site.

### 3.7 POOL 17

Freshwater mussels were surveyed at two sites in Pool 17; the Big Timbers Site and the Jonas Johnson Island Site. The Big Timbers Site (RM 444-445) is situated in the middle of Pool 17 approximately 11.8 miles downstream from Lock and Dam 16 and 7.6 miles upstream of Lock and Dam 17. The Jonas Johnson Island Site (RM 438-441) is located in the lower end of Pool 17, approximately 1.4 miles upstream of Lock and Dam 17. Both sites are presently being worked by several commercial clambers. These sites were investigated to provide species composition and abundance data on commercially valuable mussel beds for use in estimation of potential impacts of channel maintenance dredging activity.

#### 3.7.1 Big Timbers Site

Brailing was conducted at five transects in August and September 1979 (Figure 18). Single brail runs of 2000 feet, were made at Transects A, B, C, and E. Sampling was intensified along Transect D to quantitatively characterize the commercial mussel bed. Six brail runs, each of 2000 feet, were conducted along Transect D. In addition, six diver-collected 0.5 m<sup>2</sup> quadrat samples were taken to evaluate brailing efficiency.

Twenty-three mussel species representing 1,840 specimens were collected by brailing and diving at this site (Table 17). No endangered species were encountered. Amblema peruviana, Megaloniaias gigantea, and Quadrula pustulosa were the most common species collected by brailing along each transect. Transect D, situated approximately 120 to 150 feet from shore, harbored the greatest abundance of mussels. Depth was approximately 18 feet and substrates were mixed gravel and detritus. Amblema peruviana, Fusconaia undata, M. gigantea, Q. pustulosa and Quadrula quadrula were the principal species collected by brailing at Transect D. Noteworthy among the assemblage at Transect D was the collection of one individual of the special status species, Cumberlandia monodonta and four individuals of the rarely collected Plethobasus cyphus.

Diver-collected quadrat samples taken along Transect D at Location F revealed the presence of substantial numbers of two small species, Truncilla donaciformis and Truncilla truncata. These two taxa were rarely collected in the brail runs along Transect D and illustrated the relative inefficiency of the brail in collecting smaller species. The quantitative quadrat samples also recovered much larger overall densities of mussels along Transect D than was observed by brailing. The results of quadrat samples revealed mean mussel densities of 86 individuals/m<sup>2</sup> along Transect D. Brailing along Transect D averaged approximately 54 mussels/500-ft run, or approximately 0.1 mussels/m<sup>2</sup>. Based on these results, brailing was computed to be less than 0.1% as efficient as quadrat sampling. Quantitative samples collected by divers at this same site in 1977 revealed densities to be approximately 30 mussels/m<sup>2</sup> (Wapora, Inc. 1977). Fewer small species were collected in 1977 than in 1979; therefore, the densities appear lower in 1977.

As noted above, no Endangered species were collected at this site during 1979; however, two live individuals of Lampsilis higginsii were collected from this bed during 1977 (Wapora, Inc. 1977) and one specimen was collected in 1978 (Nelson and Freitag 1980). Two species not usually collected in the Mississippi River, Fusconaia ebenus and Tritogonia verrucosa, were collected at this site in 1976 (van der Schalie and Bates 1976). Wapora, Inc. (1977) and van der Schalie and Bates (1976) also collected C. monodonta during their surveys of the Big Timbers bed.

### 3.7.2 Jonas Johnson Island Site

Brailing was conducted along five transects near Jonas Johnson Island. Transects A, B and C were situated in a commercially valuable mussel bed, which was reported to have a population of the Endangered species, Lampsilis higginsii (Wesley Wheeler, commercial clammer, personal communication, 1979). The bed was situated along an eroding river bend in channel border habitat. Single 2,000-ft brail runs were conducted along Transects A, B and C. The river bottom ranged from a silt and sand mixture near shore (Transect B and C) to predominantly fine sand near the main channel (Transect A; Figure 19).

Few mussels (a total of 17 individuals) were collected along Transect A; however, single representatives of the Endangered L. higginsii and the uncommon species Plethobasus cyphus were recorded from this transect (Table 18). Additional quantitative diver-sampling was attempted approximately 375 to 400 feet from shore at a depth of 19 feet in the area where L. higginsii was collected; however, the densities were so small (approximately 1 to 3 mussels/m<sup>2</sup>) that the sampling was subsequently discontinued.

The greatest mussel concentrations within the bed were found along Transect B aligned 225 to 350 feet from shore and Transect C, 130 to 300 feet from shore. Brailing resulted in the collection of 32 mussels/500-ft run along Transect B and 22 mussels/500-ft run on Transect C. The dominant species taken in the bed were Amblema peruviana, Quadrula pustulosa, and Megaloniais gigantea.

Upstream from Jonas Johnson Island, near Bogus Island, brailing was conducted to confirm the presence of a cross-channel bed near RM 440 (Wesley Wheeler, commercial clammer, personal communication, 1979). Single brail runs were conducted across the main channel at Transects D and E (Figure 19). Sampling determined heavy concentrations of mussels in the main channel along Transect D (maximum of 47 mussels/run); however, the bed did not continue completely across the channel. A relatively large number of Obovaria olivaria, which were common in the shifting sand of the main channel in other pools, were also found in the stable sand-gravel substrate of this main channel bed. The only juvenile of Ligumia recta latissima recorded in the present survey was collected at this site. This individual was brailed by its byssal thread.

Additional brail and hand collections near Bogus Island (Location F) did not reveal mussel densities of the extent observed in the main channel bed. Amblema peruviana dominated the brail samples in this area and Corbicula fluminea was the only species collected by raking.

There have been no recent documented surveys in this portion of the Upper Mississippi River.



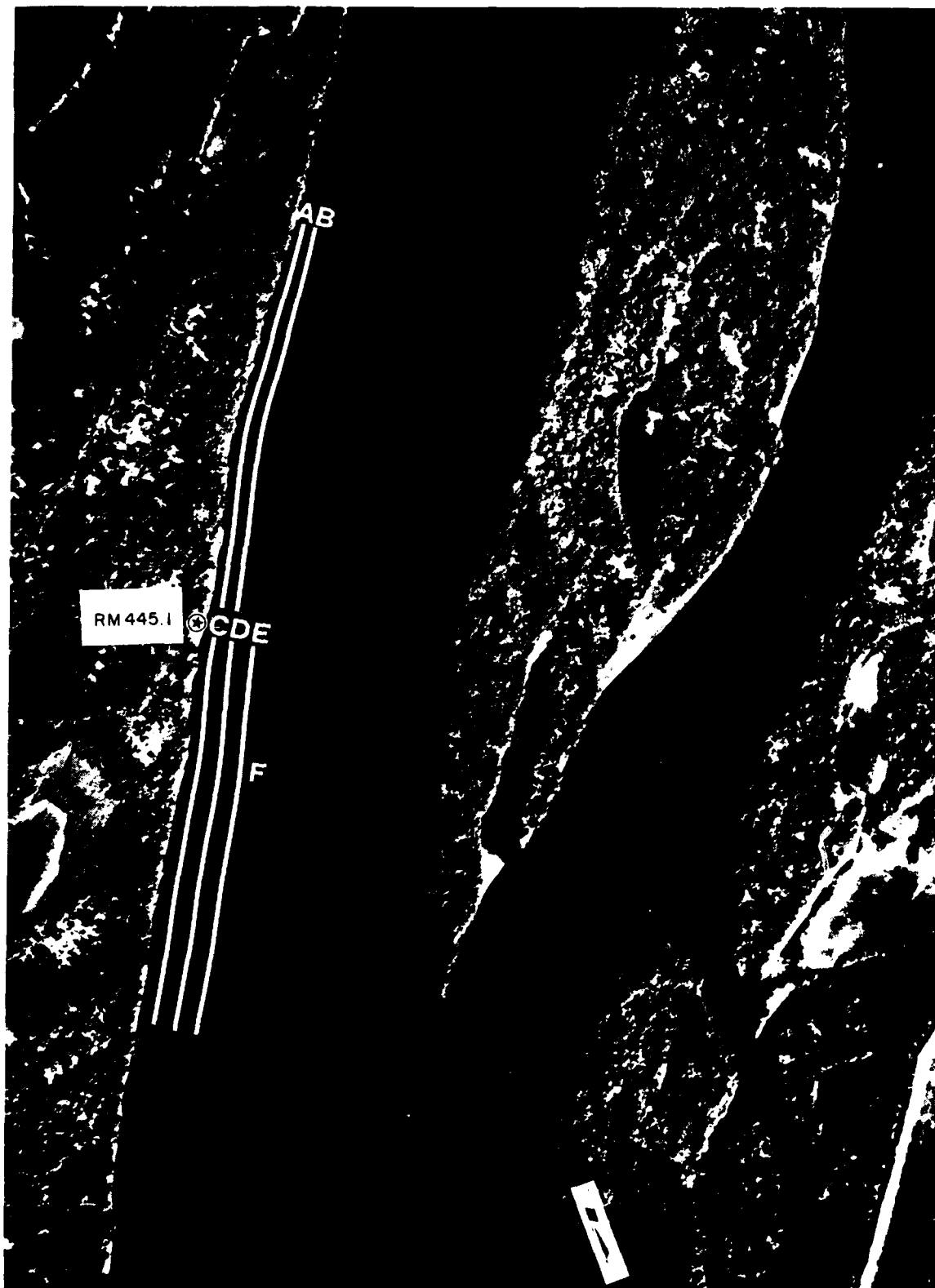


Figure 18. Collection locations near the Big Timbers Site in Pool 17 of the Mississippi River (RM 444.7-445.4), August and September 1979.

Table 17. Freshwater mussels collected near the Big Timbers Site in Pool 17 of the Mississippi River (RM 444.7-445.4), August and September 1979.

Organism	Brail Transect <sup>a</sup>										Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	G	H	I	J		
MARGARITIFERIDAE												
CUMBERLANDIINAE												
CUMBERLANDIA MONODONTA	0	0	0	0	0	1	0	0	0	0	1	1
UNIONIDAE												
AMBLEMINAE												
AMBLEMA PERUVIANA	64	40	16	37	36	42	70	49	70	11	11	455
FUSCONAIA UNDATA	9	4	4	12	6	20	33	15	24	0	1	119
MEGALONAIAS GIGANTEA	29	1	24	48	21	23	40	22	54	0	0	275
QUADRULA METANEVRA	0	0	0	6	0	5	20	9	3	1	4	45
Q. NODULATA	0	1	0	1	0	0	2	0	1	1	1	7
Q. PECTOLOSA	26	24	2	41	16	51	101	76	52	26	30	447
Q. QUADRULA	9	6	2	0	3	13	31	30	15	11	0	131
UNIONINAE												
ACTINONAIAS CARINATA	0	0	0	1	2	2	6	6	1	0	0	17
ANODONTA CORPULENTA	3	4	4	1	0	0	0	0	0	0	0	12
ARCIDENS CONFRAGOSUS	0	0	1	1	1	7	4	4	3	0	1	22
LAMPSILIS VENTRICOSA	0	0	0	2	1	3	12	7	4	27	2	55
LASMIGNA COMPLANATA	1	0	1	1	0	0	0	0	0	0	0	3
LEPTODEA FRAGILIS	2	2	0	0	0	1	1	1	0	0	0	14
L. LAEVISSIMA	1	0	0	0	0	1	0	0	0	0	1	3
LIGUMIA RECTA LATISSIMA	0	0	0	1	0	2	1	2	2	1	0	9
OBLIGUARIA REFLEXA	0	0	1	1	0	0	5	1	0	0	1	9
OBOVARIA OLIVARIA	0	1	0	4	1	2	24	11	1	0	2	51
PLAGIOLA LINEOLATA	0	0	0	10	1	9	12	11	8	0	0	64
PLETHOBASUS CYPHYUS	0	0	0	0	0	0	2	0	2	0	0	4
PROPTERA ALATA	0	0	2	0	1	3	2	4	1	0	1	14
TRUNCILLA DONACIFORMIS	0	0	0	0	1	0	0	0	0	0	18	19
T. DONACIFORMIS JUV.	3	0	1	0	0	0	0	0	0	0	1	5
T. TRUNCATA	0	0	0	0	0	2	2	0	2	0	17	23
TOTAL IN EACH SAMPLE	147	89	58	173	90	187	370	248	249	100	109	1841

<sup>a</sup>Transect A, 2000 ft brail run, main channel border, Iowa side.

Transect B, 2000 ft brail run, main channel border, Iowa side.

Transect C, 2000 ft brail run, main channel border, Iowa side.

Transect D, 2000 ft brail run, main channel border, Iowa side.

Transect E, 2000 ft brail run, main channel border, Iowa side.

<sup>b</sup>Location F, results of six 0.5 m<sup>2</sup> quadrat samples along Transect D.



Figure 19. Collection locations near the Jonas Johnson Island Site in Pool 17 of the Mississippi River (RM 438.5-441.2), August 1979.

Table 18. Freshwater mussels collected near the Jonas Johnson Island Site in Pool 17 of the Mississippi River (RM 438.5-441.2), August 1979.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	
CORBICULIDAE							
CORBICULA FLUMINEA	0	0	0	0	0	10	10
UNIONIDAE							
AMBLEMINAE							
AMBLEMA PERUVIANA	0	38	22	18	21	38	137
FUSCONAIA UNDATA	0	9	4	5	3	3	24
MEGALONAIAS GIGANTEA	0	22	23	18	4	5	72
QUADRULA METANEVRA	0	0	0	2	0	0	2
Q. NODULATA	0	0	2	1	0	1	4
Q. PUSTULOSA	8	34	14	13	5	5	79
Q. QUADRULA	0	8	11	4	2	3	28
UNIONINAE							
ACTINONAIAS CARINATA	0	0	0	1	0	0	1
ANODONTA CORPULENTA	0	0	0	0	0	1	1
ARCIDENS CONFRAGOSUS	0	1	0	2	1	1	5
LAMPSILIS HIGGINSII	1	0	0	0	0	0	1
L. VENTRICOSA	3	3	3	3	2	1	15
LEPTODEA FRAGILIS	0	2	0	0	0	0	2
L. FRAGILIS JUV.	0	0	2	0	0	0	2
L. LAEVISSIMA	1	0	0	0	0	1	2
LIGUMIA RECTA LATISSIMA	0	0	0	1	1	0	2
L. RECTA LATISSIMA JUV.	0	0	0	1	0	0	1
OBLIQUARIA REFLEXA	0	1	1	1	0	0	3
OBOVARIA OLIVARIA	3	5	2	15	3	1	29
PLAGIOLA LINEOLATA	0	0	0	1	3	0	4
PLETHOBASUS CYPHYUS	1	0	0	0	0	0	1
PROPTERA ALATA	0	3	3	0	0	0	6
TRUNCILLA TRUNCATA	0	0	0	0	0	1	1
T. DONACIFORMIS JUV.	0	1	0	0	0	0	1
TOTAL IN EACH SAMPLE	17	127	87	86	45	71	433

<sup>a</sup>Transect A, 2000 ft brail run, main channel border, Illinois side.

Transect B, 2000 ft brail run, main channel border, Illinois side.

Transect C, 2000 ft brail run, main channel border, Illinois side.

Transect D, brail run, main channel.

Transect E, brail run, main channel.

<sup>b</sup>Location F, hand collecting and brail runs near Bogus Island.

### 3.8 POOL 18

Mussels were surveyed during September 1979 at the New Boston, Huron Island and Benton Island sites in Pool 18. The New Boston site (RM 433-435) contained a commercially valuable mussel bed (Perry 1979) approximately one mile long. This bed was surveyed to provide comparative data in evaluation of channel maintenance activities. Huron Island (RM 424) and Benton Island (RM 418-419) were examined in reference to future channel maintenance dredging and spoil placement. Huron Island is situated near Keithsburg, Illinois, in the middle of Pool 18, and the Benton Island site is located in the lower portion of Pool 18 just upstream of Oquawka, Illinois.

#### 3.8.1 New Boston Site

The New Boston Site was situated 1.9 mile downstream of Lock and Dam 17 near the mouth of the Iowa River. Five transects (A through E) were established to evaluate the known commercial bed along the Iowa channel border habitat (Figure 20). Single brail runs of 6000 feet were conducted at Transects A and B in the Iowa channel border. Transects C, D and E in the main channel were sampled by single 1,000-ft brail runs. A single exploratory 2,500-ft brail run was conducted at Transect G in the Illinois channel border. In addition to brailing, hand collecting was conducted at Location F approximately one mile upstream of Transects A and B along the Iowa shoreline. Six diver-collected 0.5 m<sup>2</sup> quadrat samples were taken along Transect B to test brailing efficiency and to obtain a quantitative measure of composition and abundance within this commercially valuable mussel bed.

Twenty-four species representing 894 mussels were collected in the New Boston site during September, 1979 (Table 19). The greatest concentrations of mussels occurred along Transect B, aligned approximately 190 to 250 feet from shore. Mussel densities averaged approximately 31 mussels/500-ft run. Depth ranged from 17 to 20 feet and substrates were stable sand, silt and gravel mixtures. Densities of mussels decreased by approximately one-half, near shore along Transect A. Along Transects C, D and E, in the areas near the sandy main channel, mussels were sparse (Table 19).

Amblema peruviana was the predominant species collected by brailing at the New Boston site, but several other species also were abundant. Of special note were large numbers of Quadrula metanevra and Actinonaias carinata, which are relatively uncommon species in the Mississippi River. Two individuals of the rarely collected Fusconaia ebenus also were found at this site. No Endangered species were observed.

The relative inefficiency of brail sampling that was noted at the Big Timbers Site was substantiated at the New Boston Site. Quantitative samples collected by Scuba diving along Transect B revealed a mean density of 124 mussels/m<sup>2</sup> in this bed compared to approximately 0.06/m<sup>2</sup> by brailing. This converted to a brailing efficiency of less than 0.1%. Smaller taxa such as Obliquaria reflexa and species of Truncilla, were missed by brailing, but were collected in large numbers in the hand-picked quadrat samples.

Exploratory brail samples along Transect G near the Illinois shore resulted in numerous mussels, but no new species or commercially valuable beds were discovered. Hand collections in the slough upstream from the mussel bed (Location F) yielded three additional species for this site. The uncommon species Carunculina parva and the introduced species Corbicula fluminea were recorded from this location.

In 1975, Perry (1979) also brailed the mussel bed along the Iowa shore at RM 434.5. He reported the rarely collected Plethobasus cyphus and 15 other species which were all observed in the present survey. Further downstream near RM 434.1, Perry conducted brail runs in the Illinois channel border and main channel but collected no mussels.

### 3.8.2 Huron Island Site

The Huron Island Site was surveyed to evaluate the impact of future channel maintenance dredging. This recurring dredge site is between Snipe Island and the north end of Huron Island 13.7 miles upstream of Lock and Dam 18 and 12.5 miles downstream of Lock and Dam 17. Channel maintenance dredging was conducted four times at the Huron Island Site from 1945 through 1973 (USACOE 1974). Five transects (Transects A through E) were established within the main channel and channel border areas of the potential dredge site (Figure 21). Single 2,500-ft brail runs were conducted along each of the five transects. Additional sampling was undertaken to evaluate past and future spoil disposal sites. Historically, spoil material was placed along Snipe and Huron Islands near Locations G and H (Figure 21). Hand collecting was conducted at each of the historical spoil disposal sites. The proposed disposal site along the Illinois shoreline just downstream of Snipe Island was sampled by brailing and hand collecting at Location F.

The main channel and the Illinois main channel border areas in the proposed dredge site contained medium grain sand substrate and depth was approximately 18 feet at flat pool. Shallower depths (approximately 15 feet) were found along the Iowa main channel border. The subsurface current velocity during the September 1979 survey ranged from 2.9 to 3.5 feet per second. The slough between Snipe Island and the Illinois shore contained a clay substrate overlain with silt. A silty substrate was encountered along the Huron Island disposal site.

Eight freshwater mussel species were collected at the Huron Island Site during September 1979 (Table 20). Main channel and channel border brail runs in the area of the potential dredge cut (Transect A, B, C, D and E) yielded sparse populations of Lampsilis ventricosa and Obliquaria reflexa. Six species were observed in collections near the historic dredge disposal site on Snipe Island (Location G). Brail runs along the west side of Snipe Island (approximately 100 feet from shore) and the slough east of Snipe Island yielded juvenile Leptodea fragilis, Leptodea laevis, and Truncilla donaciformis attached by their byssal threads (Location G). Several individuals of Anodonta corpulenta and Carunculina parva were recorded from the hand collections in the slough east of Snipe Island. Corbicula fluminea was the only species collected from the historic disposal area (Location H) along Huron Island. Brail and hand collections along the Illinois shore near the future disposal site (Location F) yielded no mussels.

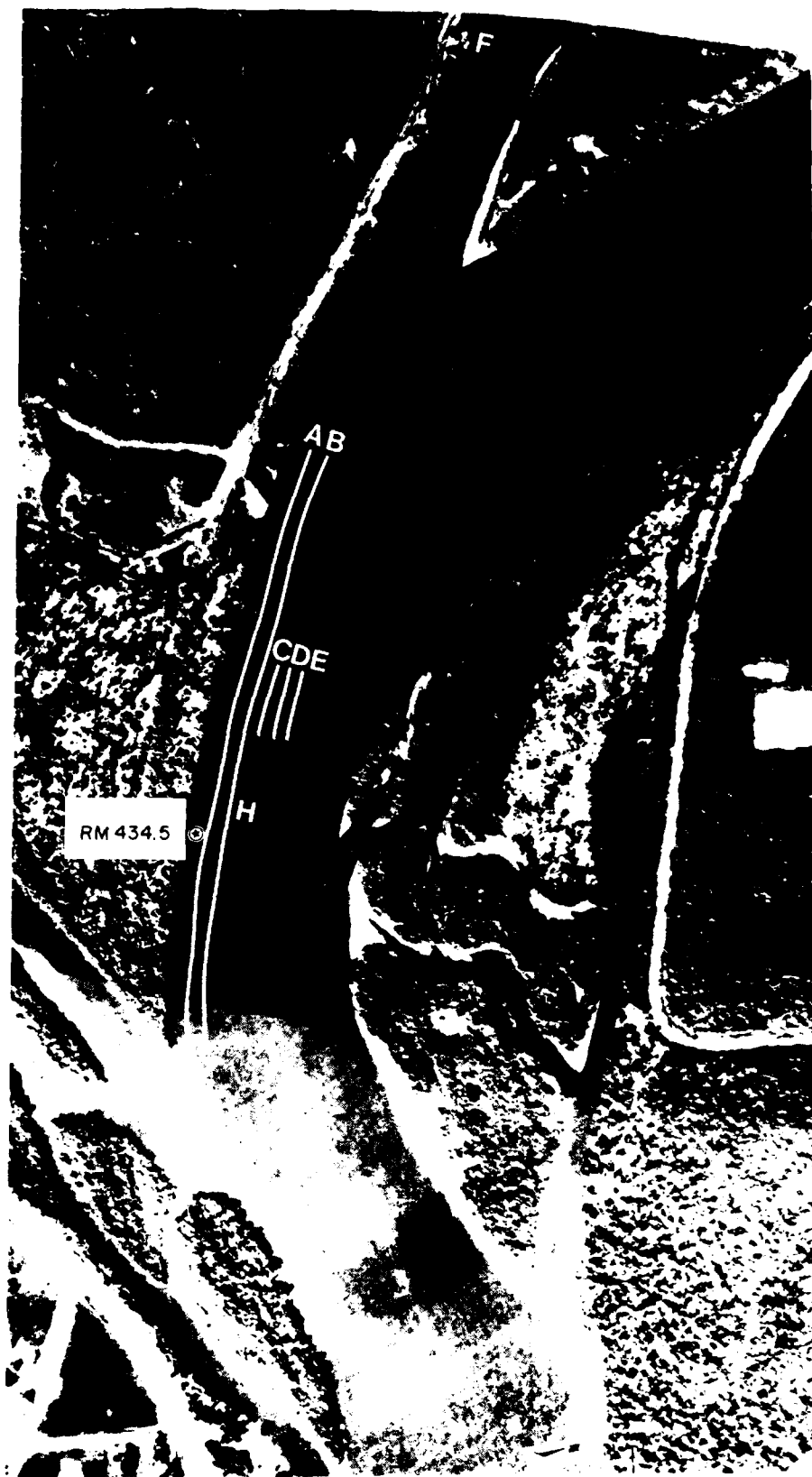


Figure 20. Collection locations near the New Boston Site in Pool 1: of the Mississippi River (RM 433.4-435.2), September 1979.

Table 19. Freshwater mussels collected near the New Boston Site in Pool 18 of the Mississippi River (RM 433.4-435.2), September 1979.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>			Total Mussels
	A	B	C	D	E	F	G	H	
CORBICULIDAE									
CORBICULA FLUMINEA	0	0	0	0	0	4	0	1	5
UNIONIDAE									
AMBLEMINAE									
AMBLEMA PERUVIANA	66	79	1	0	0	0	47	27	220
FUSCONAIA EBENUS	1	1	0	0	0	0	0	0	2
F. UNDATA	12	33	0	0	0	0	6	8	59
MEGALONAIAS GIGANTEA	19	47	0	0	0	0	0	10	76
QUADRULA METANEVRA	4	19	0	0	0	0	1	3	27
Q. NODULATA	1	1	0	0	0	0	0	1	3
Q. PUSTULOSA	24	42	1	1	0	0	21	41	130
Q. QUADRULA	12	38	1	0	0	0	12	8	71
UNIONINAE									
ACTINONAIAS CARINATA	5	24	2	0	0	0	6	11	48
ANODONTA CORPULENTA	11	3	0	0	0	3	2	1	20
A. IMBECILLIS	0	0	0	0	0	1	0	0	1
ARCIDENS CONFRAGOSUS	2	6	0	1	0	0	0	3	12
CARUNCULINA PARVA	0	0	0	0	0	1	0	0	1
LAMPSILIS VENTRICOSA	5	16	1	1	0	0	3	3	29
LEPTODEA FRAGILIS	3	5	1	0	0	0	0	7	16
L. LAEVISSIMA	1	0	0	0	0	1	0	1	3
LIGUMIA RECTA LATISSIMA	0	1	0	0	0	0	1	0	2
OBLIQUARIA REFLEXA	5	8	1	0	0	0	3	15	32
OBOVARIA OLIVARIA	6	22	4	1	0	0	3	4	40
PLAGIOLA LINEOLATA	10	18	5	1	0	0	2	8	44
PROPTERA ALATA	6	1	0	0	0	0	0	0	7
TRUNCILLA DONACIFORMIS	3	2	0	0	0	0	0	14	19
T. TRUNCATA	3	3	0	1	0	0	0	20	27
TOTAL IN EACH SAMPLE	199	369	17	6	0	10	107	186	894

<sup>a</sup>Transect A, 6000 ft brail run, main channel border, Iowa side.

Transect B, 6000 ft brail run, main channel border, Iowa side.

Transect C, 1000 ft brail run, main channel.

Transect D, 1000 ft brail run, main channel.

Transect E, 1000 ft brail run, main channel.

<sup>b</sup>Location F, hand collecting, nearshore, Iowa side.

Location G, 2500 ft brail run, main channel border, Illinois side.

Location H, results of six 0.5 m<sup>2</sup> quadrat samples along Transect B, main channel border, Iowa side.



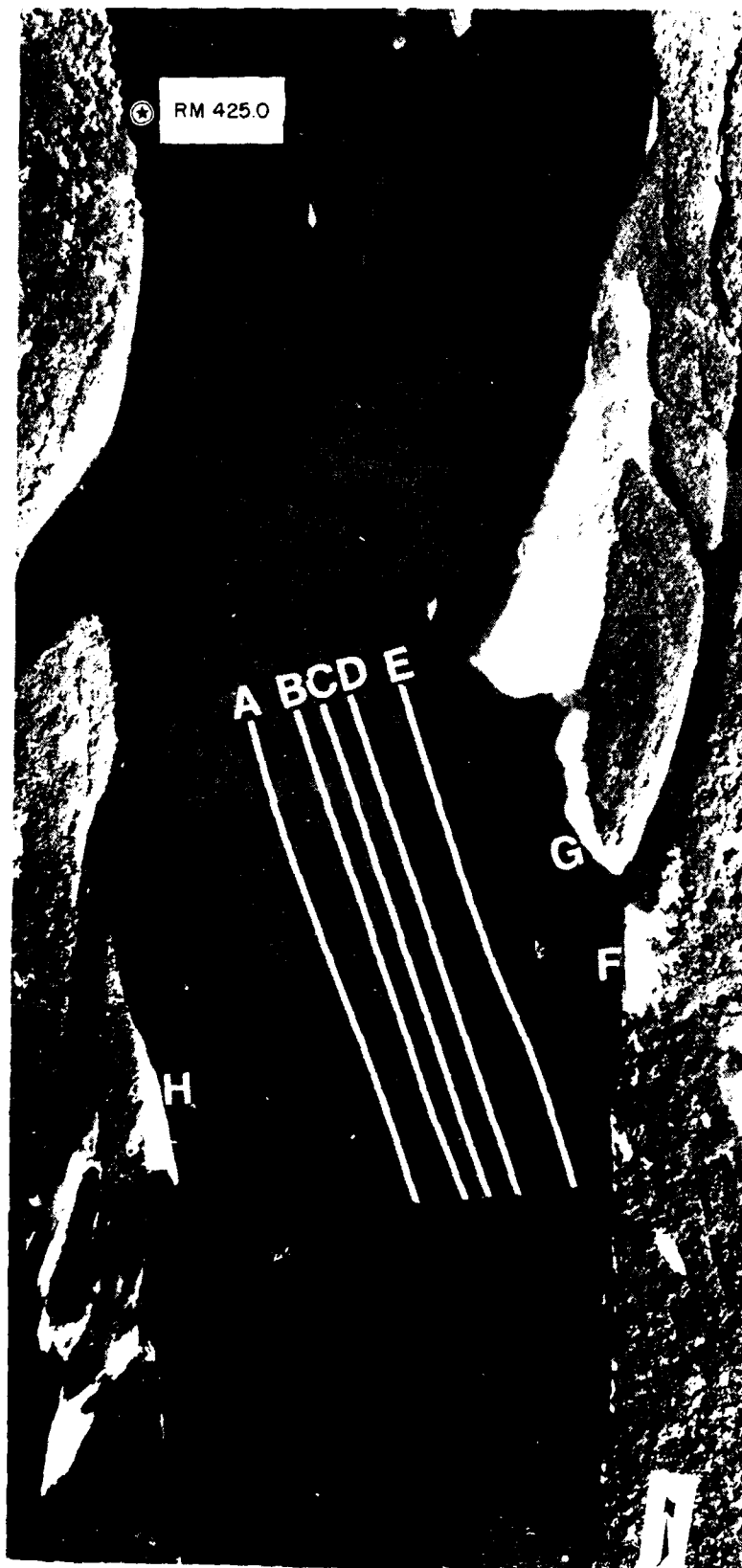


Figure 21. Collection locations near the Huron Island Site in Pool 18 of the Mississippi River (RM 424.0-424.6), September 1979.

Table 20. Freshwater mussels collected near the Huron Island Site in Pool 18 of the Mississippi River (RM 424.0-424.6), September 1979.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>			Total Mussels
	A	B	C	D	E	F	G	H	
CORBICULIDAE									
CORBICULA FLUMINEA	0	0	0	0	0	0	0	12	12
UNIONIDAE									
UNIONINAE									
ANODONTA CORPULENTA	0	0	0	0	0	0	7	0	7
CARUNCULINA PARVA	0	0	0	0	0	0	6	0	6
LAMPSILIS VENTRICOSA	0	0	0	0	2	0	0	0	2
LEPTODEA FRAGILIS JUV	0	0	0	0	0	0	2	0	2
L. LAEVISSIMA	0	0	0	0	0	0	3	0	3
L. LAEVISSIMA JUV.	0	0	0	0	0	0	3	0	3
OBLIQUARIA REFLEXA	0	0	0	1	1	0	0	0	2
TRUNCILLA DONACIFORMIS JUV.	0	0	0	0	0	0	1	0	1
TOTAL IN EACH SAMPLE	0	0	0	1	3	0	22	12	38

<sup>a</sup>Transect A, 2500 ft brail run, main channel border, Iowa side.

Transect B, 2500 ft brail run, main channel, dredge site.

Transect C, 2500 ft brail run, main channel, dredge site.

Transect D, 2500 ft brail run, main channel, dredge site.

Transect E, 2500 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, hand collecting and brail run, nearshore, Illinois side, historic and potential disposal site.

Location G, hand collecting, nearshore, Snipe Island, Illinois side, historic disposal site.

Location H, hand collecting, nearshore, Iowa side, historic disposal site.

Freitag (1978) reported only six mussel species in very low densities from an area just upstream of the Huron Island Site (RM 425.1-426.2) during a 1978. Four of the six species reported by Freitag, Quadrula nodulata, Quadrula pustulosa, Quadrula quadrula and Amblema peruviana were not collected in the present study. Perry (1979) did not collect any mussels in brail runs along Huron Island at RM 425.3 and 426.5. He did, however, collect a few mussels further downstream at RM 423.3, but did not record the species.

Dredging and dredge spoil placement probably would have little detrimental effect upon the mussel population at the Huron Island site. The small densities of the reported species and the absence of any Endangered species preclude this site as an area of major impact.

### 3.8.3 Benton Island Site

Channel maintenance dredging was conducted three times between 1945 and 1973 at the Benton Island Site in the lower stretch of Pool 18 (USACOE 1974). Dredging was required once in the upper reaches and twice in the downstream portion of the site. Future dredging at the Benton Island Site probably will be conducted in mid-channel along the full length of Benton Island. Four transects (Transects A through D) were established in the main channel and main channel-border areas to evaluate mussel populations in the proposed dredge area (Figure 22 and Table 21). Single brail runs ranging from 3500 to 4500 feet were conducted along each transect. Dredge spoil during previous channel maintenance has been placed either along the upstream portion of Benton Island near Transect E (Figure 22), or along the shore of Jacoby Islands near location F. The proposed disposal site, located in the historical site along Benton Island near Transect E, was surveyed by brailing and hand collections. The historical site along Jacoby Islands was surveyed by hand collecting.

The substrate at the proposed dredge site ranged from fine sand along the Iowa main channel border to medium and coarse grain sand in the main channel and Illinois main channel border. Depths in the main channel ranged from 15 feet in the upstream portion of the proposed cut to 22 feet at the downstream end. Depths of approximately 10 feet were recorded along the upstream portion in the Iowa main channel border. Current in the main channel during the September 1979 sampling ranged from 2.4 to 3.0 ft/sec. Substrates encountered along the Benton Island disposal site were predominantly silty sand. Along the Jacoby Islands disposal site the substrates ranged from sand at the upstream end to gravel with pockets of fine sand and clay downstream.

A total of 18 mussel species representing 211 individuals were collected at the Benton Island Site during September 1979 (Table 21). Quadrula pustulosa and Olivaria olivaria were the most abundant taxa of the 16 species collected from the main channel and channel border brail runs (Table 21). The majority of the mussels were collected near the downstream end of the proposed cut in the Iowa main channel and main channel border areas. Hand picking and brailing near the shore along the Benton Island disposal site yielded only small numbers of mussels. Leptodea laevis and Corbicula fluminea were the dominant species encountered. A diverse and relatively abundant mussel assemblage was collected along the Jacoby Islands historic disposal site. The majority of the mussels were collected near the downstream end of the island. Quadrula pustulosa, Quadrula quadrula, Obliquaria reflexa and Amblema peruviana were the most abundant species observed.

Very little historical data is available from this area of the river. Perry (1979) reported collecting a few mussels upstream of Benton Island at RM 421.4 but did not report the taxa he observed. One dead shell of the Endangered species, Lampsilis higginsii, was reported by the U.S. Fish and Wildlife Service (USFWS 1980) from RM 416 in May 1966.

Dredging at the Benton Island Site will likely have little effect upon the mussel assemblage since the majority of the mussels inhabit the downstream end of the area in depths not requiring maintenance dredging. Care should be taken with any future dredging to avoid the downstream portions of the channel and channel border habitats. The proposed disposal of dredge spoils on Benton Island will have little effect upon the mussels since this was not an area of high mussel density.

### 3.9 POOL 19

#### 3.9.1 Rush Island Site

The Rush Island Site was the only area investigated within Pool 19 during the 1979-1980 mussel survey. This site, situated near Burlington, Iowa, in the upstream portion of Pool 19 (RM 404-407) has sustained repeated channel maintenance dredging. It is the most frequently and heavily dredged area in Pool 19. Dredging was conducted 14 times between 1945 and 1973. Over 100,000 cubic yards were removed from this dredge site during seven of the 14 maintenance actions.

The main channel and main channel border areas of the Rush Island dredge site were surveyed by 6,000-ft brail runs along five transects (Figure 23). Transects A and E were situated in channel border habitats and Transects B, C, and D were positioned in potential dredging areas within the main channel.

Historically, the following four spoil areas have been used at the Rush Island Site: 1) the Illinois shoreline across the river from the southern tip of Otter Island; 2) the southern tip of Otter Island (Location G); 3) the western shore of Willow Bar Island (Location F); and 4) along Rush and Baby Rush Islands (Location H). A spoil closure now exists between these latter two islands and was caused by the high water of 1973 which carried spoil off of Rush Island into the cut between the islands (R.M. Baker, USACOE, personal communication, 1979). Future dredge spoil probably will be placed on the west shore of Willow Bar Island (Location F).

The main channel area in the proposed dredge site contained primarily medium to coarse sand with an area of gravel at the extreme upper end. Flat pool depth ranged from 13 to 18 feet in the area of the proposed cut and currents at the time of sampling ranged from 2.5 to 3.5 ft/sec. The substrate near the Otter Island disposal site and at the upstream end of Willow Bar Island was a silt-clay mixture with a small amount of sand. Further downstream at Willow Bar Island and along the shore of Rush Island, the substrates were primarily sand.

Twenty-two freshwater mussel species, totaling 395 specimens, were collected at the Rush Island Site during September 1979 (Table 22). Only seven individuals, representing three taxa, were taken from the proposed dredge site area.



Figure 22. Collection locations near the Benton Island Site in Pool 16 of the Mississippi River (RM 418.7-419.6), September 1979.

Table 21. Freshwater mussels collected near the Benton Island Site in Pool 18 of the Mississippi River (RM 418.7-419.6), September 1979.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	
CORBICULIDAE							
CORBICULA FLUMINEA	0	0	0	0	7	3	10
UNIONIDAE							
AMBLEMINAE							
AMBLEMA PERUVIANA	0	4	1	0	4	13	22
FUSCONAIA UNDATA	1	0	0	0	1	3	5
MEGALONAIAS GIGANTEA	1	3	0	0	0	0	4
QUADRULA NODULATA	2	3	1	0	0	4	10
Q. PUSTULOSA	10	17	0	0	1	22	50
Q. QUADRULA	1	6	0	0	2	10	19
UNIONINAE							
ACTINONAIAS CARINATA	0	1	0	0	0	0	1
ANODONTA CORPULENTA	1	1	0	0	2	5	9
CARUNCULINA PARVA	0	0	0	0	0	1	1
LAMPSILIS VENTRICOSA	2	4	0	0	0	0	6
LEPTODEA FRAGILIS	1	2	0	0	0	0	3
L. LAEVISSIMA	1	0	0	0	5	7	13
LIGUMIA RECTA LATISSIMA	0	3	0	0	0	0	3
OBLIQUARIA REFLEXA	1	1	0	0	0	18	20
OBOVARIA OLIVARIA	1	15	2	3	2	0	23
PROPTERA ALATA	0	1	1	0	0	1	3
TRUNCILLA DONACIFORMIS	1	1	0	0	3	4	9
TOTAL IN EACH SAMPLE	23	62	5	3	27	91	211

<sup>a</sup>Transect A, 3500 ft brail run, main channel border, Iowa side, dredge site.

Transect B, 4500 ft brail run, main channel, dredge site.

Transect C, 4500 ft brail run, main channel, dredge site.

Transect D, 4500 ft brail run, main channel border, Illinois side, potential dredge site.

Transect E, 1500 ft brail run and hand collecting, nearshore, Illinois side, historic and potential disposal site, Benton Island.

<sup>b</sup>Location F, hand collecting, Iowa side, historic disposal site, Jacoby Islands.



Figure 23. Collection locations near the Rush Island Site in Pool 19 of the Mississippi River (RM 404.4-407.1), August 1979.

Table 22. Freshwater mussels collected near the Rush Island Site in Pool 19 of the Mississippi River (RM 404.4-407.1), August 1979.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>			Total Mussels	
	A	B	C	D	E	F	G	H		I
CORBICULIDAE										
CORBICULA FLUMINEA	0	0	0	0	0	2	0	2	0	4
UNIONIDAE										
AMBLEMINAE										
AMBLEMA PERUVIANA	0	0	0	0	0	19	6	4	52	81
FUSCONAIA UNDATA	0	0	0	0	0	5	6	6	9	26
MEGALONAIAS GIGANTEA	0	0	0	0	0	1	0	0	3	4
QUADRULA METANEVRA	0	0	0	0	0	0	0	0	1	1
Q. NODULATA	0	0	0	0	0	1	0	0	1	2
Q. PUSTULOSA	1	2	0	1	5	4	12	3	15	43
Q. QUADRULA	0	0	0	0	0	0	0	0	10	10
UNIONINAE										
ACTINONAIAS CARINATA	0	0	0	0	0	0	1	0	0	1
ANODONTA CORPULENTA	0	0	0	0	0	0	1	2	1	4
A. IMBECILLIS	0	0	0	0	0	1	4	0	0	5
ARCIDENS CONFRAGOSUS	0	0	0	0	0	0	0	0	1	1
LAMPSILIS VENTRICOSA	1	0	0	0	4	8	14	3	8	38
LEPTODEA FRAGILIS	0	0	0	0	0	4	8	0	0	12
L. LAEVISSIMA	3	0	0	0	0	37	4	12	0	56
OBLIQUARIA REFLEXA	1	0	0	0	1	3	5	0	8	18
OBOVARIA OLIVARIA	5	0	3	0	3	1	2	0	4	18
PLAGIOLA LINEOLATA	0	0	0	0	0	0	0	0	3	3
PROPTERA ALATA	0	0	0	0	0	6	3	0	1	10
TRUNCILLA DONACIFORMIS	0	0	0	0	0	20	18	12	0	50
T. TRUNCATA	0	0	0	1	0	0	4	1	1	7
JUV. UNIONIDAE	0	0	0	0	0	1	0	0	0	1
TOTAL IN EACH SAMPLE	11	2	3	2	13	113	88	45	118	395

<sup>a</sup>Transect A, 6000 ft brail run, main channel border, Iowa side.

Transect B, 6000 ft brail run, main channel, dredge site.

Transect C, 6000 ft brail run, main channel, dredge site.

Transect D, 6000 ft brail run, main channel, dredge site.

Transect E, 6000 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, hand collecting and 2000 ft brail run, nearshore, Willow Bar Island, Illinois side, historic and potential disposal site.

Location G, hand collecting, nearshore, Otter Island, Iowa side, historic disposal site.

Location H, hand collecting, nearshore, Big Rush Island, Iowa side, historic disposal site.

Location I, brail runs, 2000 ft, main channel border, Iowa side, downstream at RM 404.4, exploratory site.



This was not unexpected since this is an area of high natural sedimentation and frequent dredging activity. Quadrula pustulosa and Obovaria olivaria were the dominant taxa collected from the brailing runs at the proposed cut site and channel border areas (Transects A, B, C, D, and E.)

Brailing and handpicking along the disposal area of Willow Bar Island (Location F) yielded 113 specimens (Table 22). Amblema peruviana and Leptodea laevis were the dominant taxa collected by pollywogging in the silty clay substrate along the western shoreline near the upper end of the island. Further downstream where the substrate was gravelly sand, Truncilla donaciformis and young L. laevis were the dominant mussels. Brailing along Willow Bar Island (approximately 90 feet from shore) yielded few mussels (Table 22).

Fourteen taxa were collected along the Otter Island disposal area (Location G). Lampsilis ventricosa, Q. pustulosa, and T. donaciformis were the dominant mussels collected. Most of the specimens were collected 20 to 30 feet from shore near the downstream end of the island in areas with negligible current. Juveniles of Anodonta imbecillis, L. laevis, T. donaciformis and Truncilla truncata were recorded in the backwater area west of Otter Island by brailing.

Along the Rush Island and Baby Rush Island disposal areas (Location H), fewer specimens and fewer total taxa were collected than along the other disposal sites. The dominant taxa at Location H were the same as occurred at the other disposal sites examined.

Exploratory brailing runs were also made in an area of a known mussel bed downstream (RM 404.4) of the proposed cut. The area investigated was along the Iowa side of the river just upstream of the Burlington bridge in an area where the substrate was rubble interspersed with sand. A diverse and relatively abundant mussel assemblage was located approximately 400 feet from shore. A total of 118 mussels (15 taxa) were collected in 2,000 feet of brailing. Amblema peruviana composed almost half of the total assemblage. Other abundant species included Fusconia undata, L. ventricosa, Obliquaria reflexa, Q. pustulosa, and Quadrula quadrula.

Very little historical data is available for this area of the river. Perry (1979) made brailing runs upstream along Otter Island at RMs 408.5 and 409.2 upstream of Rush Island and in O'Connell Slough at RM 405.1. A few live mussels were collected; however, species' identifications were not recorded for either site.

Dredging probably would have little detrimental effect upon the mussel assemblage at the Rush Island Site. The extremely small densities of mussels and the absence of any rare or Endangered species precludes this as an area of major impact. Care should be taken with dredge spoil placement along Willow Bar Island because several mussel taxa were reported from this disposal site. Spoil should be placed as far onto the island as possible to prevent siltation of habitats along the western shoreline of Willow Bar Island.

### 3.10 POOL 20

Mussel surveys were conducted at three potential dredge sites in Pool 20. Warsaw Harbor (RM 358-359) in the upper reach of Pool 20 and the Gregory Lower Site (RM 351-353) in the central section of Pool 20 were both classified as recurrent dredge sites (USACOE 1974). The third site, Buzzard Island (RM 347-349), is located in the lower portion of Pool 20 and was surveyed relative to proposed channel maintenance involving a dam closure between two islands.

#### 3.10.1 Warsaw Harbor Site

Warsaw Harbor is located 4.7 miles downstream of Locks and Dam 19, one-half mile downstream of Warsaw, Illinois. Rapid silt accumulation in this small boat harbor has required frequent, low volume dredging (usually less than 13,000 cubic yards). Classified as a recurrent dredging site, Warsaw Harbor was dredged seven times between 1967 and 1973 (USACOE 1974). The repeated dredging has been attributed to sedimentation via the upstream opening of the harbor into the river proper.

Three brailing transects, 4,000 feet in length were established to assess the impact of dredging in Warsaw harbor (Figure 24). Brail transects encompassed an area approximately 1,000 feet upstream to 3,000 feet downstream of the harbor entrance. Transects were parallel and positioned in channel border habitats at distances of 80, 150 and 300 feet from the Illinois shoreline.

Dredge spoils historically have been disposed of on the shoreline immediately downstream of the harbor entrance. It is likely that future spoil will be placed in this area. Hand collecting of mussels was conducted nearshore at this spoil disposal site (Location D).

Depth in the harbor was 3 to 4 feet and the substrate was a clay and silt mixture. Depth along nearshore Transect C was 4 feet and the substrates were silty sand. The transects nearer the channel (Transects A and B) were 5 to 7 feet deep and contained a fine sand substrate. The shoreline downstream from the harbor in the vicinity of the spoil disposal site (Location D) had a sand substrate.

Eight mussel species totaling 36 individuals were recorded from the Warsaw Harbor Site during October 1979 (Table 23). No special status species were observed at this site. The greatest abundance of mussels at Warsaw Harbor was recorded along Transect C, located 80 feet from shore. Amblema peruviana, Quadrula pustulosa, and Quadrula quadrula were the species most commonly encountered. Brail runs conducted 300 and 150 feet from shore (Transects A and B, respectively) revealed a sparse fauna in the channel border areas. Only two individuals were collected along Transect B and no mussels were collected on Transect A. Hand collections from the area of the spoil disposal site downstream of the harbor mouth (Location D) yielded only a single mussel, Leptodea fragilis. Exploratory raking and hand collecting in the harbor yielded no mussels. The absence of mussels in the harbor was attributed to the frequent dredging of this site.

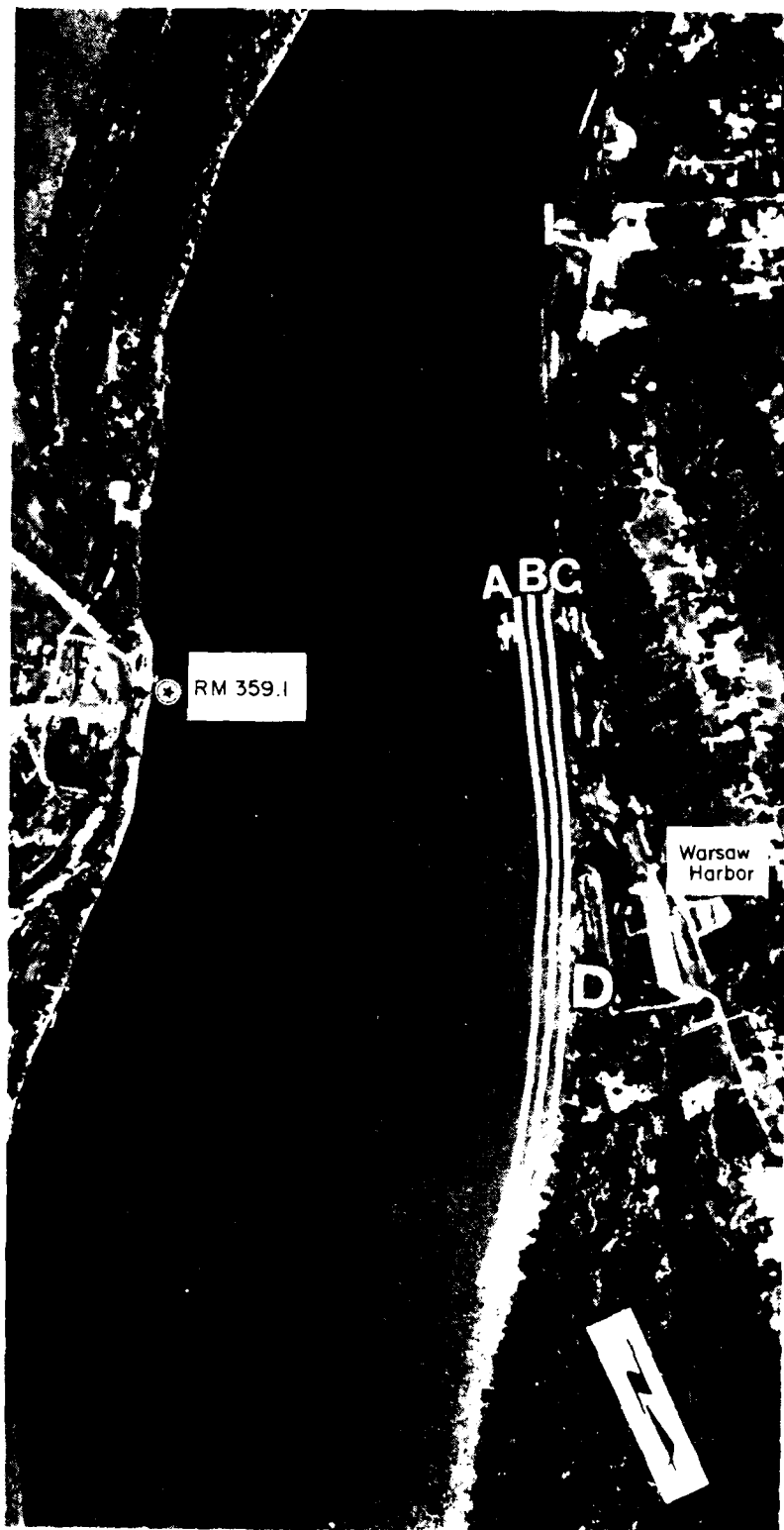


Figure 24. Collection locations near the Warsaw Harbor Site in Pool 20 of the Mississippi River (RM 359.1-359.11, October 1979).

Table 23. Freshwater mussels collected near the Warsaw Harbor Site in Pool 20 of the Mississippi River (RM 358.A-359.4), October 1979.

Organism	Brail Transect <sup>a</sup>			Other <sup>b</sup>	Total Mussels
	A	B	C	D	
UNIONIDAE					
AMBLEMIDAE					
AMBLEMA PERUVIANA	0	0	8	0	8
FUSCONAIA UNDATA	0	0	2	0	2
QUADRULA NODULATA	0	0	2	0	2
Q. PUSTULOSA	0	1	12	0	13
Q. QUADRULA	0	0	6	0	6
UNIONINAE					
LEPTODEA FRAGILIS	0	0	0	1	1
OBOVARIA OLIVARIA	0	1	1	0	2
TRUNCILLA DONACIFORMIS JUV.	0	0	2	0	2
TOTAL IN EACH SAMPLE	0	2	33	1	36

<sup>a</sup>Transect A, 4000 ft brail run, main channel border, Illinois side, harbor maintenance area.

Transect B, 4000 ft brail run, main channel border, Illinois side, harbor maintenance area.

Transect C, 4000 ft brail run, main channel border, Illinois side, harbor maintenance area.

<sup>b</sup>Location D, hand collecting, nearshore, Illinois side, historic and potential disposal site.

Brail collections downstream from this site at RM 358.3 during 1976 were void of mussels (USFWS 1980); however, approximately four miles upstream from Warsaw Harbor, near Keokuk, Iowa, samples by Freitag (1978) and Fuller (1979) contained 21 species. Two relatively uncommon species, Fusconaia ebenus and Plethobasus cyphus were collected by Fuller, but no Endangered species were present.

The absence of Endangered species and the relatively low abundance of mussels near the Warsaw Harbor Site suggest that Corps of Engineers dredging will have little impact upon the mussel fauna in this area of Pool 20.

### 3.10.2 Gregory Lower Site

The Gregory Lower Site near RM 351 is located 8.0 miles upstream of Lock and Dam 20. This site, classified as a recurrent dredging area, was dredged five times between 1960 and 1973 (USACOE 1974). Brailing was conducted along five parallel transects in July 1980 to assess the potential impact of maintenance dredging (Figure 25). Transects A and B were positioned within the main channel and Transects C, D, and E were situated within the Illinois channel border. Each of these brail transects constituted a 2,500-ft run.

Three spoil disposal sites have been utilized in past channel maintenance dredging (Figure 25). Hand collecting and brailing were conducted at these three locations (Locations H, I and J) to assess the spoil sites. Spoil historically has been placed along the Missouri shoreline upstream of Buzzard Island, and at the upstream end of Buzzard Island (Location J). The small Illinois island at RM 351.6 has also been utilized for previous spoil disposal. Brailing (1,500-ft runs) was conducted at Transects F and G along the eastern and western sides of this small island. In addition, hand collections were conducted along the southern tip of the Illinois island spoil site (Location H). Future spoil disposal probably will be on the Illinois shore between the Hunt Drainage District levee and river shoreline. Hand collecting and brailing were employed along the shoreline of this potential disposal site (Location I).

A fine to medium sand substrate was encountered at all main channel and channel border brail run transects. Most of the disposal sites had a silty sand substrate; however, a silt and clay bottom was present at the downstream end of the Illinois island disposal site. Water depths in and near the main channel ranged from 14 to 18 feet and channel border Transects D through G ranged from 3 to 5 feet. An unusually large diurnal fluctuation in water level, probably a result of the operation of the Union Electric hydroelectric power plant at Keokuk, was noted at this site.

Ninety-eight freshwater mussels comprising 11 species were recorded in the Gregory Lower Site during July 1980 (Table 24). No Endangered or special status species were collected during this survey. Only two mussels were collected by brailing near the potential dredge cut and the Illinois island disposal site (Transects A through G); however, several mussels were collected from the silt-clay substrate immediately downstream from the Illinois island disposal site (Location H). Amblema peruviana was the dominant species at this location. The Missouri disposal site (Location J) contained a sparse mussel fauna (seven individuals) and collections along the Illinois shore of the potential disposal site (Location I) yielded only one mussel, Obovaria olivaria.

Exploratory collections were conducted in an upstream back water area (location K) and resulted in the collection of numerous *A. peruviana* and *Isconaiia undata*. In addition, relic valves of the Endangered species *Optera capax* were discovered on this site.

data on this area of Pool 20 are sparse. Sampling was conducted by Perry (1979) downstream from this site at RM 350.0 but no mussels were encountered. Fuller (1978) conducted a survey upstream at RM 353.8-355.9 and reported 10 species, but no special status species were found at this site.

Future channel maintenance activity at the Gregory Lower Site will probably have little effect upon the mussel fauna of this portion of Pool 20. The scarcity of mussels in the main channel and channel border preclude deleterious impacts due to the potential dredge cut. Impacts from spoil disposal will also be minimal in light of the proposed terrestrial disposal at the Illinois shoreline site.

### 10.3 Buzzard Island Site

The Buzzard Island Site is located approximately 5.8 miles upstream from Lock and Dam 20. Mussels were surveyed at this site in relation to a proposed dam closure between Huff and Hunt Islands. The dam closure is designed to divert more river flow into the main channel. Five brailling transects were established in the side channel area to assess potential impacts of the closure (Figure 26). Transects A, B, and C each extended from the point of closure, 5,000 feet downstream. Transects D and E were positioned within the side channel and consisted of 4,000 and 3,000-ft braill runs, respectively.

The river bottom in this side channel habitat was predominantly fine sand with a maximum depth of 15 feet at the mouth of the side channel. Depth decreased to 10 to 12 feet downstream. A current of 1.5 to 1.8 ft/sec was recorded at the upstream end of the side channel.

Only three species, representing a total of five individuals were collected near the Buzzard Island Site during October 1979 (Table 25). No Endangered or other special status species were recorded. *Obovaria olivaria* was the most commonly collected species at this site. Raking and pollywogging, in addition to brailling, were utilized in this side channel but were unproductive.

Fuller (1978) investigated an area immediately upstream from this site at RM 347.9-349.7 during 1977 and reported 53 mussels representing nine species. *Quadrula quadrula* was the most abundant taxon collected by Fuller. Perry (1979) collected six species of mussels at RM 346.4 and 348.7. Among these species was a specimen of the uncommon *Lampsilis anodontoides anodontoides* collected near Polly Island. No Endangered species were reported from either of these surveys.

The proposed dam closure between Huff and Hunt Islands probably will reduce to a fluence only a few mussels in this sparsely inhabited side channel.

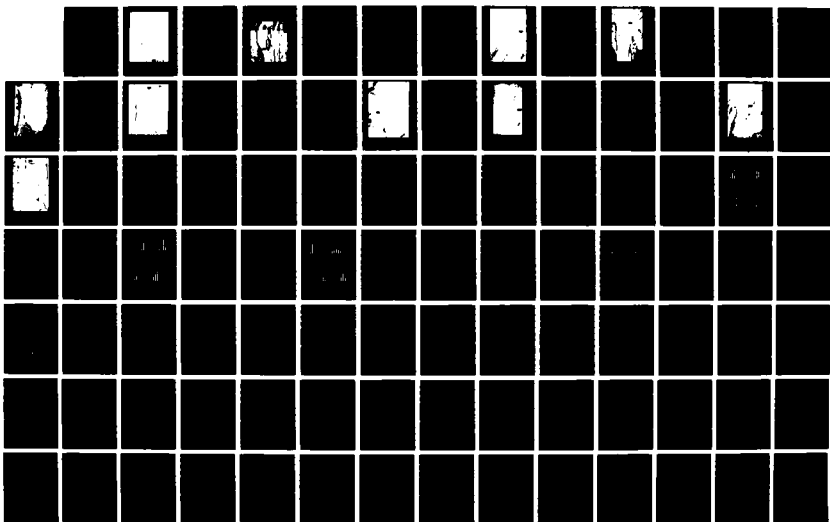
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SURVEY OF FRESHWATER MUSSELS (PELECYPODA: UNIONACEA) AT 2/3  
SELECTED SITES IN (U) ECOLOGICAL ANALYSTS INC  
NORTHBROOK IL APR 81 EA-9031

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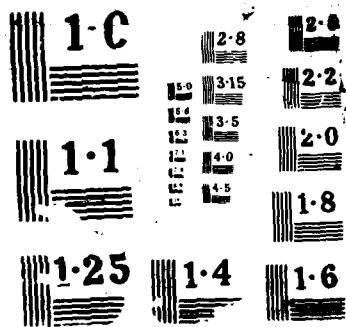






Figure 25. Collection locations near the Gregory Lower Site in Pool 20 of the Mississippi River (RM 351.2-353.1), July 1980.

Table 24. Freshwater mussels collected near the Gregory Lower Site in Pool 20 of the Mississippi River (RM 351.2-353.1), July 1980.

Organism	Brail Transect <sup>a</sup>							Other <sup>b</sup>				Total Mussels
	A	B	C	D	E	F	G	H	I	J	K	
UNIONIDAE												
AMBLEMINAE												
AMBLEMA PERUVIANA	0	0	0	0	0	0	0	12	0	5	49	66
FUSCONAIA UNDATA	0	0	0	0	0	0	0	2	0	0	8	10
QUADRULA MODULATA	0	0	0	1	0	0	0	0	0	0	0	1
Q. PUSTULOSA	0	0	0	0	0	0	0	4	0	1	2	7
Q. QUADRULA	0	0	0	0	0	0	0	0	0	1	1	2
UNIONINAE												
ANODONTA CORPULENTA	0	0	0	0	0	0	0	0	0	0	2	2
LAMPSILIS VENTRICOSA	0	0	0	0	0	0	0	1	0	0	0	1
LEPTODEA LAEVISSIMA	0	0	0	0	0	0	0	0	0	0	1	1
OBLIQUARIA REFLEXA	0	0	0	0	0	0	0	3	0	0	1	4
OBOVARIA OLIVARIA	0	0	0	0	1	0	0	1	1	0	0	3
PROPTERA ALATA	0	0	0	0	0	0	0	1	0	0	0	1
TOTAL IN EACH SAMPLE	0	0	0	1	1	0	0	24	1	7	64	98

<sup>a</sup>Transect A, 2500 ft brail run, main channel, dredge site.

Transect B, 2500 ft brail run, main channel, dredge site.

Transect C, 2500 ft brail run, main channel border, Illinois side.

Transect D, 2500 ft brail run, main channel border, Illinois side.

Transect E, 2500 ft brail run, main channel border, Illinois side.

Transect F, 1500 ft brail run, nearshore, west side of historic Illinois island disposal site.

Transect G, 1500 ft brail run, nearshore, east side of historic Illinois island disposal site.

<sup>b</sup>Location H, hand collecting, nearshore, historic Illinois island disposal site.

Location I, hand collecting and brail, nearshore, potential Illinois disposal site.

Location J, hand collecting, nearshore, historic Missouri disposal site, Buzzard Island.

Location K, hand collecting, slough, Illinois side, exploratory site.



Figure 26. Collection locations near the Buzzard Island Site in Pool 20 of the Mississippi River (RM 347.5-349.0), October 1979.

Table 25. Freshwater mussels collected near the Buzzard Island Site in Pool 20 of the Mississippi River (RM 347.5-349.0), October 1979.

	Brail Transect <sup>a</sup>					Total Mussels
	A	B	C	D	E	
UNIONIDAE						
UNIONINAE						
LEPTODEA LAEVISSIMA	0	1	0	0	0	1
OBOVARIA OLIVARIA	0	2	1	0	0	3
TRUNCILLA TRUNCATA	0	1	0	0	0	1
TOTAL IN EACH SAMPLE	0	4	1	0	0	5

<sup>a</sup>Transect A, 5000 ft brail run, side channel, Illinois side, closure structure replacement.

Transect B, 5000 ft brail run, side channel, Illinois side, closure structure replacement.

Transect C, 5000 ft brail run, side channel, Illinois side, closure structure replacement.

Transect D, 4000 ft brail run, side channel, Illinois side, closure structure replacement.

Transect E, 3000 ft brail run, side channel, Illinois side, closure structure replacement.

### 3.11 POOL 21

Mussel surveys were conducted at three channel maintenance sites in Pool 21. The LaGrange Site (RM 335-337), Hogback Island Site (RM 331-332) and Lone Tree Light Site (RM 330-331) were all surveyed during August of 1980. Each site has sustained dredging operations in the past and each is scheduled for future maintenance activities.

#### 3.11.1 LaGrange Site

The LaGrange channel maintenance site is located in the upper section of Pool 21 near LaGrange, Missouri (Figure 27). The site is approximately 5.9 miles downstream from Lock and Dam 20 and 10.7 miles upstream from Lock and Dam 21. The section of river surveyed at the LaGrange Site included two areas, one near RM 336 and the other near RM 337. The RM 337 site was dredged 11 times during 1945 through 1968. The recurrent dredging area at RM 336 was dredged seven times from 1964 through 1973 (USACOE 1974).

This area was surveyed on 27 and 28 August 1980 just prior to maintenance dredging by the USACOE. The exact locations of the dredge cuts (included in Transects B, C, and D) and the disposal sites were decided by the On-site Inspection Team a few days before the dredging began. Historically, the spoil has been placed along the Missouri shoreline (near Location F) and in the open water near the Illinois island shore. The historic Missouri disposal site and a wooded area between the historic site and the Wyaconda River were the tentative selections for the future spoil placement. Hand collecting was conducted at Location F in the vicinity of the proposed spoil disposal area.

The main channel and channel border in the area of the proposed dredge cut varied from 10 to 14 feet in depth with a substrate of medium and fine sand. The substrate along the Missouri disposal site was primarily gravel and sand with some pockets of silt.

Sixteen species were collected near the LaGrange Site during August 1980 (Table 26). Brailing conducted in the area of the proposed dredge cut, and the historic and proposed dredge sites (Transects A through E), yielded no mussels. Hand collections along the shore of the historic Missouri disposal site (Locations F) produced several species of mussels; however, numbers of individuals were sparse (Table 26). A young individual of Lampsilis anodontoides anodontoides (4 years old) was the only uncommon species collected. No Endangered or other special status species were recorded; however, a relic valve of the Endangered Proptera capax was found along the Missouri disposal shoreline.

In addition to surveying the potential dredging and spoil sites, brailing was conducted downstream from the Missouri disposal site in a mussel bed with historic commercial value. Brailing produced 36 clams representing 11 species, including three individuals of the rarely collected Fusconaia ebenus (Table 26). Amblema peruviana and Quadrula quadrula were the most abundant species in this mussel assemblage. The present concentration of mussels was not considered commercially valuable.

Perry (1979) reported three species collected near the shore of LaGrange Island at RM 335.5 in 1976 and six species downstream of the LaGrange Site near the Missouri shore. An upstream dredge site at RM 338.5-340.3 was investigated by Fuller (1978) and resulted in the collection of 69 mussels distributed among 11 species. Arcidens confragosus was the only species collected in these recent surveys which was not recorded at the LaGrange Site; however, the present survey reported five species which have not been recorded previously in this portion of Pool 21. No endangered or special status species were collected in these past surveys near the LaGrange Site.

Sixteen species were reported in the LaGrange, Missouri area in the survey by Max M. Ellis during 1930-1931 (van der Schalie and van der Schalie 1950). Two species collected by Ellis, Tritogonia verrucosa and the presently Endangered P. capax, were not recorded live at any site in the Upper Mississippi River during this 1979-1980 survey. Another species which Ellis collected, Leptodea laevis, was not present at the LaGrange Site, but was reported from the two other sites in Pool 21 investigated during the present survey. Representatives of Ligumia recta latissima, Lampsilis ventricosa and Truncilla truncata were observed at this site in 1980 but were absent in the 1930-1931 collections.

The dredging which was conducted at the LaGrange Site during 1980 probably had little impact upon the mussel fauna. The scarcity of mussels in and near the main channel and the terrestrial disposal of the spoil probably resulted in negligible impact upon the mussel assemblage.

### 3.11.2 Hogback Island Site

The Hogback Island Site is situated in the middle section of Pool 21 approximately 6.8 miles upstream from Lock and Dam 21 and extends downstream to within 10.4 miles of Lock and Dam 20. This recurrent dredging site near RM 332 was dredged 10 times from 1951 through 1973 (USACOE 1974). The volume removed from this site has occasionally been heavy. In 1967, 432,000 cubic yards were dredged. Three braill transects (Transects B, C, and D, each 5,000 feet in length) were established in the channel and channel border habitats near the potential dredge cut (Figure 28).

In the past, spoil has been placed along the Hogback Island disposal site, which now is a popular recreational beach, and along the Missouri shoreline. The Hogback Island disposal site was surveyed for mussels by both brailling along Transect E (2,000-ft run) and hand collecting at Location G (Figure 28). Future disposal may be at the Hogback Island disposal or along the Missouri shore in front of the Union Township levee. The Missouri shoreline disposal site was sampled by brailling on Transect A (5,000-ft run) and hand collecting at Location F.

The substrate in this section of the river was almost entirely sand. Some sections of the river along the Missouri shore which were protected from scouring by currents contained appreciable percentages of silt. Depth in the main channel was 11 to 13 feet and decreased to approximately 8 feet near shore.

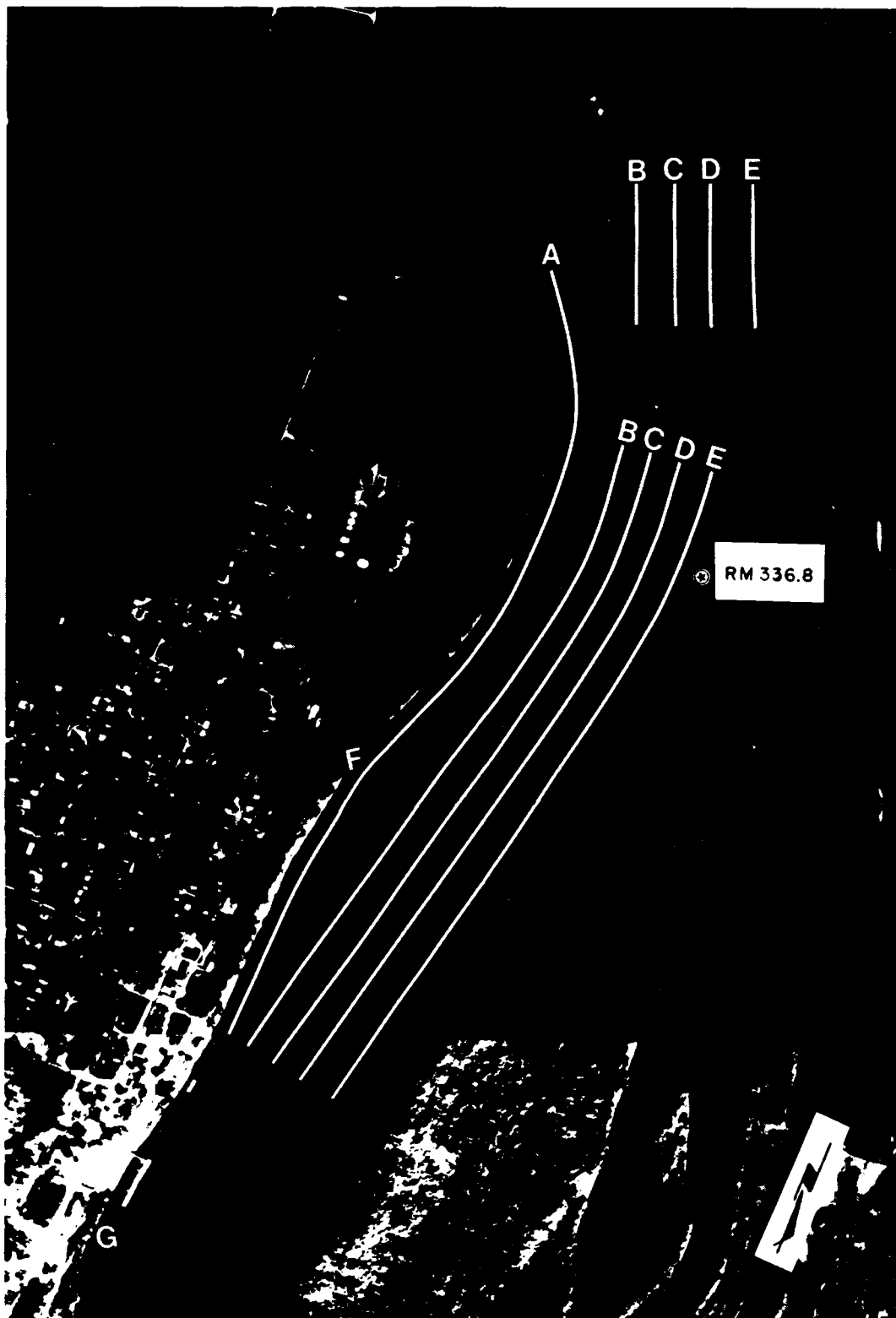


Figure 27. Collection locations near the LaGrange Site in Pool 21 of the Mississippi River (RM 335.6-337.3), August 1980.

Table 26. Freshwater mussels collected near the LaGrange Site in Pool 21 of the Mississippi River (RM 335.6-337.3), August 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINAE								
AMBLEMA PERUVIANA	0	0	0	0	0	2	8	10
FUSCONAIA EBENUS	0	0	0	0	0	0	3	3
F. UNDATA	0	0	0	0	0	0	3	3
QUADRULA METANEVRA	0	0	0	0	0	0	1	1
Q. NODULATA	0	0	0	0	0	2	0	2
Q. PUSTULOSA	0	0	0	0	0	1	4	5
Q. QUADRULA	0	0	0	0	0	1	7	8
UNIONINAE								
LAMPSILIS ANODONTOIDES								
ANODONTOIDES	0	0	0	0	0	1	0	1
L. VENTRICOSA	0	0	0	0	0	1	1	2
LEPTODEA FRAGILIS	0	0	0	0	0	1	0	1
L. FRAGILIS JUV.	0	0	0	0	0	1	0	1
LIGUMIA RECTA LATISSIMA	0	0	0	0	0	0	1	1
OBLIQUARIA REFLEXA	0	0	0	0	0	3	4	7
OBOVARIA OLIVARIA	0	0	0	0	0	0	2	2
PLAGIOLA LINEOLATA	0	0	0	0	0	0	2	2
TRUNCILLA DONACIFORMIS	0	0	0	0	0	4	0	4
T. TRUNCATA	0	0	0	0	0	3	0	3
TOTAL IN EACH SAMPLE	0	0	0	0	0	20	36	56

<sup>a</sup>Transect A, 4500 ft brail run, main channel border, historic and potential Missouri disposal site.

Transect B, 4500 ft brail run, main channel, dredge site.

Transect C, 4500 ft brail run, main channel, dredge site.

Transect D, 4500 ft brail run, main channel, dredge site.

Transect E, 4500 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, hand collecting, nearshore, historic and potential Missouri disposal site.

Location G, brail runs, total of 1500 ft, main channel border, Missouri side, exploratory site.



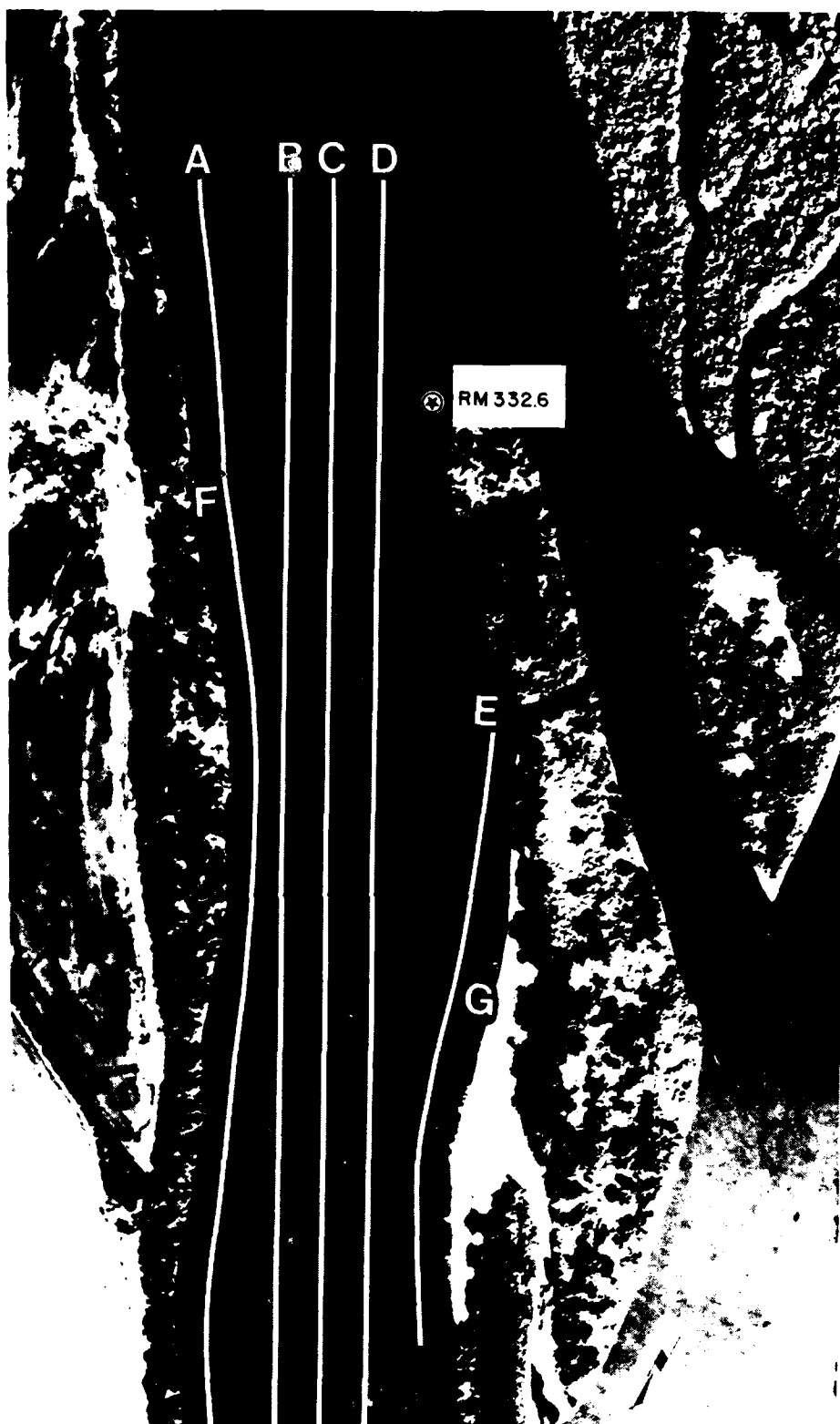


Figure 28. Collection locations near the Hogback Island Site in Pool 21 of the Mississippi River (RM 331.7-332.8), August 1980.

Table 27. Freshwater mussels collected near the Hogback Island Site in Pool 21 of the Mississippi River (RM 331.7-332.8), August 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINAE								
AMBLEMA PERUVIANA	0	0	0	0	0	1	0	1
FUSCONAIA UNDATA	0	0	0	0	0	1	0	1
QUADRULA PUSTULOSA	0	0	0	0	0	1	0	1
UNIONINAE								
LAMPASILIS ANODONTOIDES								
ANODONTOIDES	0	0	0	0	0	3	0	3
LEPTODEA LAEVISSIMA	0	0	0	0	0	1	0	1
OBLIQUARIA REFLEXA	0	0	0	0	0	3	0	3
OBOVARIA OLIVARIA	1	0	0	0	0	0	0	1
PROPTERA ALATA	0	0	0	0	0	1	0	1
TOTAL IN EACH SAMPLE	1	0	0	0	0	11	0	12

<sup>a</sup>Transect A, 5000 ft brail run, main channel border, historic and potential Missouri disposal site.

Transect B, 5000 ft brail run, main channel, dredge site.

Transect C, 5000 ft brail run, main channel, dredge site.

Transect D, 5000 ft brail run, main channel border, Illinois side.

Transect E, 2000 ft brail run, nearshore, historic Illinois disposal site.

<sup>b</sup>Location F, hand collecting, nearshore, historic and potential Missouri disposal site.

Location G, hand collecting, nearshore, historic Illinois disposal site, Hogback Island.

The mussel fauna in this section of the Mississippi River was sparse and no Endangered or special status species were collected (Table 27). Only one individual of *Obovaria olivaria* was collected in the areas of the potential dredge cut (Transects A through D). Brailing, raking and pollywogging along the Hogback Island disposal site (Transect E and Location G) were unproductive. However, a sheltered area along the Missouri shore disposal site (Location F) yielded seven species of mussels. Three individuals of the uncommon *Lampsilis anodontoides anodontoides* were recorded at this location.

Historically, numerous surveys have been conducted in this section of Pool 21, but few mussels have been reported. Perry (1979) brailed along the Illinois side of the channel near RM 332.6 and near the Missouri shore at RM 331.7 during 1976. No mussels were collected at either site. An absence of mussels was also noted in 1980 (Ecological Analysts, Inc. 1981b) and 1979 surveys (Ostdiek et al. 1980) near the historic disposal site along Hogback Island. Downstream from the Hogback Island disposal at RM 331.3 Ostdiek et al. (1980) collected 25 live mussels comprising nine species.

The sparse mussel fauna near the Hogback Island Site suggested that the proposed channel maintenance activity would have negligible influence on the mussel assemblage of Pool 21.

### 3.11.3 Lone Tree Light Site

The Lone Tree Light site (near RM 331) is located immediately downstream from the Hogback Island Site in Pool 21 (Figure 29). This channel maintenance area is situated about 6.0 miles upstream from Lock and Dam 21 and 11.7 miles downstream from Lock and Dam 20. Dredging was conducted only once at this site during the 1945-1973 period (USACOE 1974). Four 3000 ft brail transects (Transects B, C, D, and E) were established within the main channel and channel border habitats to evaluate mussel populations in the area of the proposed cut (Figure 29).

Dredge spoil during the previous dredging operation was placed along the Missouri shore. Transect A (a 2500 ft brailing run) was established to evaluate the impact of spoil disposal along the Missouri shoreline. In addition, Location F was sampled by hand in the immediate area of the disposal site (Figure 29).

The main channel and channel border areas (Transects B, C, D, and E) had predominantly sand substrates. Depth in the main channel area averaged 14 feet. Substrates along the Missouri shoreline (Transect A) varied from rubble at the upstream end of the transect to silt and clay in the downstream sections. Depth along Transect A decreased from 17 feet upstream to 3 feet downstream.

No mussels were collected near the Lone Tree Light dredge and disposal areas with the brail; however, 36 mussels representing eight species were recorded in the raking and pollywogging collections along the historical Missouri shoreline disposal site (Location F; Table 28). *Obliquaria reflexa* was the dominant species in the survey of this site. The presence of numerous young individuals (1.6-2.5 mm in length, 2-3 years old) indicated recruitment of this species.

Pollywogging near the Missouri shore disposal site during 1979 by Ostdiek et al. (1980) yielded 10 mussels comprising three species. Near the Illinois shore, at RM 331.0-331.2, Ostdiek et al. (1980) reported 13 live mussel species and 195 individuals. Brail runs conducted by Ostdiek et al. (1980) and Ecological Analysts, Inc. (1981b) near the Lone Tree Light Site generally yielded sparse numbers of mussels.

The survey in the lower stretch of Pool 21 by Ostdiek et al. (1980) recorded three species (Megaloniaias gigantea, Lasmigona complanata and Arcidens confragosus) which were not collected in the present surveys of Pool 21. Conversely, there were four species (Fusconaia ebenus, Quadrula metanevra, Anodonta imbecillis and Plagiola lineolata) recorded in the present survey which were not found by Ostdiek et al. (1980). No Endangered or special status species have been collected in any recent surveys in Pool 21.

The absence of mussels in the main channel brail samples and the sporadic occurrence of individuals along the Missouri shore disposal area suggests that channel maintenance will likely have little effect on the mussel assemblage near the Lone Tree Light Site.

### 3.12 POOL 22

Mussel surveys were conducted at four recurrent dredge sites in Pool 22. The Lock and Dam 21 Lower Approach Site (RM 323-324), Northeast Missouri Power Station Site (RM 319-320) and Beebe Island Site (RM 316) were all located in the upper section of Pool 22. Turtle Island Site (RM 311) was located in the middle section of the pool.

#### 3.12.1 Lock and Dam 21 Lower Approach Site

This site was located 0.7 mile downstream from Lock and Dam 21. Channel maintenance was conducted four times at this dredge site during 1945-1973 (USACOE 1974). Four transects (Transects A, B, C and D) were established in the main channel and channel border habitats in the vicinity of the proposed cut (Figure 30). Each transect represented a 3,500-ft brail run.

In past dredging operations, spoil has been placed on a small island along the Illinois shore. It is likely that this site will receive spoil in future maintenance activities. Transect E, a 3,000-ft brail run, and Location F, sampled by hand collection techniques, were established to evaluate mussels at this probable disposal site.

The main channel and channel border areas (Transects A through D) had substrates composed entirely of sand. Depth in the main channel was 15 to 17 feet. Numerous snags were encountered in brailing along Transect A in the Missouri portion of the main channel. Near the Illinois island disposal site (Location E), the river bottom was a silt and clay mixture and depth ranged from 6 to 9 feet.

Brail runs conducted during August 1980 yielded only three mussels representing two species (Table 29). Two individuals of Obovaria olivaria and a single representative of Obliquaria reflexa were collected from the sandy substrates of the main channel. Mussels were absent in raking and pollywogging samples taken on the eastern and western shoreline of the Illinois disposal island.

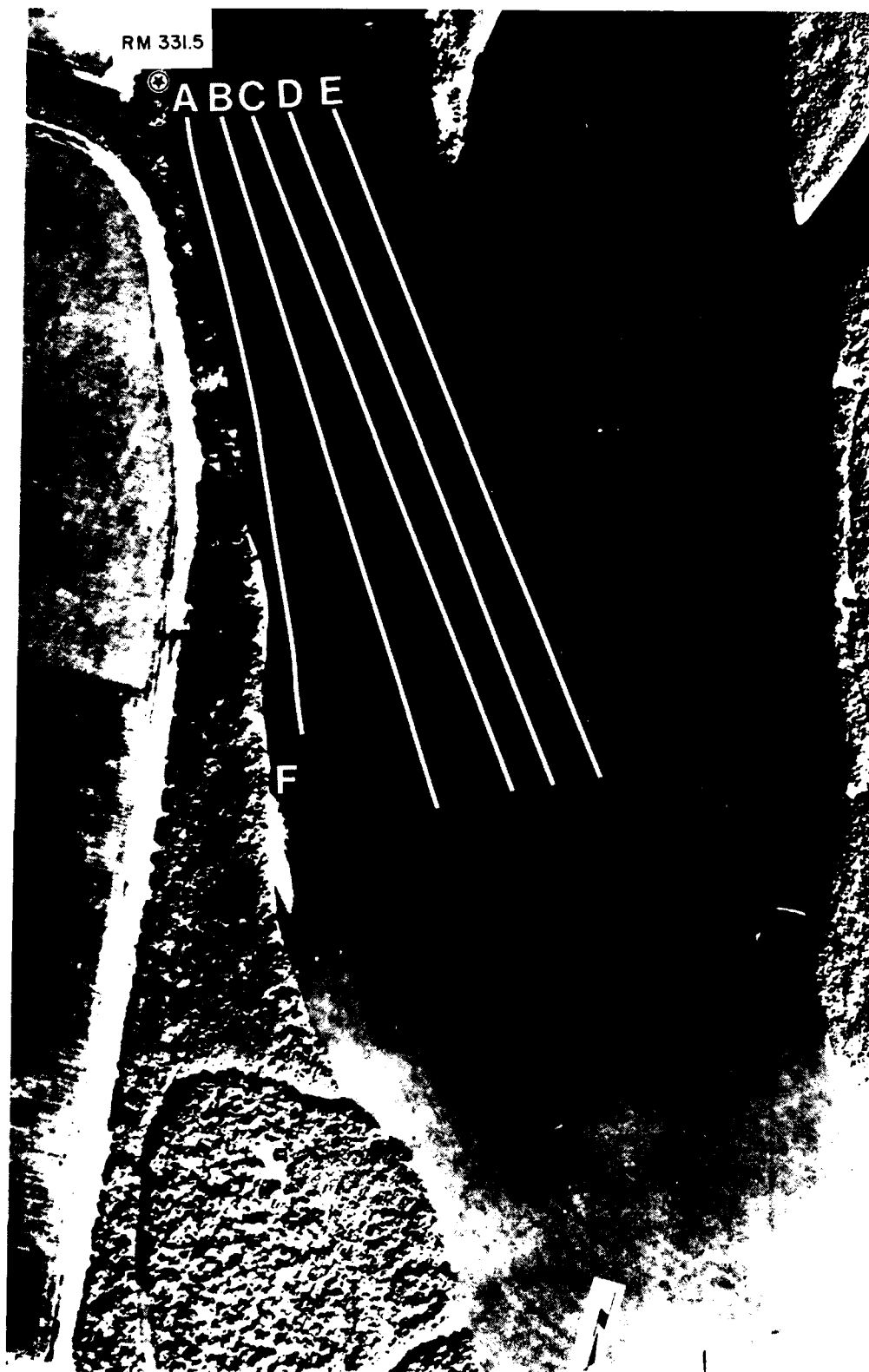


Figure 29. Collection locations near the Lone Tree Light Site in Pool 21 of the Mississippi River (RM 330.9-331.5), August 1980.

Table 28. Freshwater mussels collected near the Lone Tree Light Site in Pool 21 of the Mississippi River (RM 330.9-331.5), August 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	
UNIONIDAE							
AMBLEMINAE							
AMBLEMA PERUVIANA	0	0	0	0	0	4	4
QUADRULA PUSTULOSA	0	0	0	0	0	1	1
Q. QUADRULA	0	0	0	0	0	3	3
UNIONINAE							
ANODONTA CORPULENTA	0	0	0	0	0	4	4
ANODONTA IMBECILLIS	0	0	0	0	0	2	2
LEPTODEA LAEVISSIMA	0	0	0	0	0	1	1
OBLIQUARIA REFLEXA	0	0	0	0	0	19	19
PROPTERA ALATA	0	0	0	0	0	2	2
TOTAL IN EACH SAMPLE	0	0	0	0	0	36	36

<sup>a</sup>Transect A, 2500 ft brail run, main channel border, historic Missouri disposal site.

Transect B, 3000 ft brail run, main channel border, Missouri side.

Transect C, 3000 ft brail run, main channel, dredge site.

Transect D, 3000 ft brail run, main channel, dredge site.

Transect E, 3000 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, hand collecting, nearshore, historic Missouri disposal site.

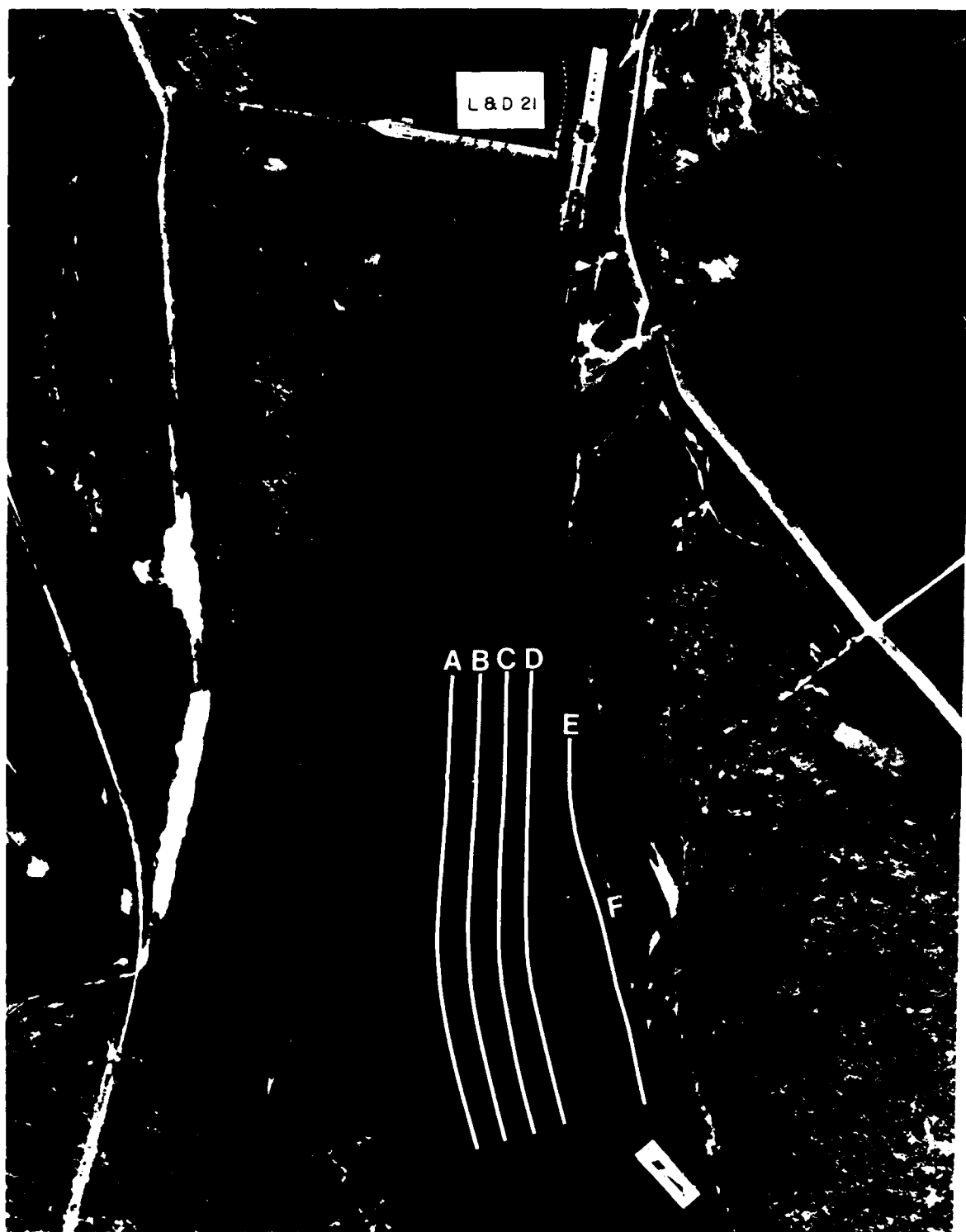


Figure 39. Collection Locations near the Lock and Dam 21 Lower Approach site in the lower of the Mississippi River (R' 323.4-324.2), August 1990.

Table 29. Freshwater mussels collected near the Lock and Dam 21 Lower Approach Site in Pool 22 of the Mississippi River (RM 323.4-324.2), August 1980.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	
UNIONIDAE							
UNIONINAE							
OBLIQUARIA REFLEXA	1	0	0	0	0	0	1
OBOVARIA OLIVARIA	1	0	1	0	0	0	2
TOTAL IN EACH SAMPLE	2	0	1	0	0	0	3

<sup>a</sup>Transect A, 3500 ft brail run, main channel border, Missouri side.

Transect B, 3500 ft brail run, main channel, dredge site.

Transect C, 3500 ft brail run, main channel, dredge site.

Transect D, 3500 ft brail run, main channel border, Illinois side.

Transect E, 3000 ft brail run, nearshore, historic and potential Illinois island disposal site.

<sup>b</sup>Location F, hand collecting, nearshore, historic and potential Illinois island disposal site.



During 1980, the Missouri main channel border immediately adjacent to the Lock and Dam 21 Lower Approach Site was brailed by Ecological Analysts, Inc. (1981c). This sampling yielded 166 mussels among 12 species. A continuous concentration of mussels was reported within 15 to 20 yards of the east banks of Orton and Fabius islands (RM 321.2-323.5). This mussel assemblage was dominated by *O. olivaria*. No Endangered species were recorded in the survey by Ecological Analysts. A brail run conducted during 1976 by Perry (1979) along Ortman Island at RM 323.6 produced no mussels.

The proposed dredge cut and spoil disposal probably will impact few mussels at the Lock and Dam 21 Lower Approach Site. Mussels were scarce at this site and no Endangered species were present. Although mussels were commonly collected in the deep water areas along the Missouri shore (Ecological Analysts, Inc. 1981c), the potential dredge cut is expected to occur in the Illinois portion of the main channel and therefore would not affect the Missouri channel border mussel fauna.

### 3.12.2 Northeast Missouri Electric Power Station Site

The Northeast Missouri Power Station Site is situated approximately 4.4 miles downstream from Lock and Dam 21 and 18.6 miles upstream from Lock and Dam 22. Historically, this site has required the most channel maintenance activity of any area in Pool 22. Dredging was conducted at this site 14 times during 1945-1973 (USACOE 1974). In 1963 and 1965, volumes greater than 100,000 cubic yards were removed. The dredge cut has been made in the Illinois portion of the main channel on the inside bend of the river where a sandy point has accreted into the navigation channel (R.M. Baker, USACOE, personal communication, 20 August 1979). Transects A, B, C, D, and E, (each 3,000-ft brail runs) were established for brailing in the main channel and channel border habitats in the area of the potential dredge cut (Figure 31).

Spoil has historically been placed along the northwestern shore of Goose Island (Location F) and along the Missouri shoreline (Location G). Qualitative hand collecting was employed at Location F to assess the mussels of this historic spoil site. In recent dredging activities, spoil has been placed on a terrestrial stockpile site on the Missouri shore at the Northeast Missouri Electric Power Station. Future disposal also will be at this terrestrial site. Brailing and diving were employed to describe the mussel fauna along the Missouri shoreline near this future disposal site (Transect A and Location G).

The main channel decreased in depth from approximately 17 feet on the Missouri side to 14 feet in the Illinois portion. A gravel-rubble substrate was present in the deep water along the rip-rapped Missouri shore (Transect A). The river bottom changed from mixed sand and gravel in the Missouri portion of the channel (Transect B) to medium grain sand in the Illinois channel border habitat (Transect E). Current velocity was 2.7 ft/sec in the main channel at the time of the survey.

The survey of the Northeast Missouri Electric Power Station Site during October 1979 yielded 150 mussels comprising 18 species (Table 30). No Endangered or other special status species were found at this site. Ten species were collected throughout the entire length of Transect A near the

Missouri shore. Numbers of mussels along this transect were relatively low, with maximum densities only 15 individuals/500-ft brailing run. Quadrula quadrula and Obovaria olivaria were the most commonly collected species at this transect. Intensive brailing and diver sampling along Transect A revealed a narrow and concentrated seam of mussels near Location G. There were no mussels collected in the main channel or the Illinois main channel border (Transects B through E). The absence of mussels in these habitats probably was a result of the unstable shifting substrates and repeated dredging at this site.

The sandy shoreline and small bays along the Goose Island historical disposal site (Location F) supported a diverse, but sporadic mussel assemblage. Fourteen species were collected including three individuals of the uncommon Lampsilis anodontoides anodontoides (Table 30). The dominant species at Location E were Quadrula nodulata and Leptodea laevis.

This area of Pool 22 has been investigated in several recent studies. Brailing, conducted along the Illinois channel border habitat during 1980 by Ecological Analysts, Inc. (1981d), resulted in no mussels. Downstream, an area along the west bank of Goose Island (RM 319.0-319.3) was surveyed in 1979 by Ost diek et al. (1980) and yielded nine species and 173 specimens. Amblema peruviana was the predominant species reported. During 1976, Perry (1979) brailed along the Missouri shore downstream from the present study area (RM 319.3) and collected only two mussels. No Endangered species were observed in any of these studies.

Mussels were sparse in the main channel and channel border habitats in the immediate vicinity of the proposed dredge cut. Dredging operations will likely have little impact upon mussels within the main channel areas; however, spoil disposal along the Missouri shoreline could impact the diverse (while not abundant) assemblage of mussels in this area. Care should be taken during future spoil disposal operations to insure that this assemblage is not disturbed.

### 3.12.3 Beebe Island Site

The Beebe Island site is located about 8.2 miles downstream from Lock and Dam 21 (Figure 32). Dredging was conducted at this site six times from 1961 through 1973 (USACOE 1974). Relatively large dredge volumes (100,000 cubic yards) were removed during three of the six operations. Six 3,000-ft brail runs (Transects A through F) were conducted in the area of the proposed dredge cut (Figure 32).

In the past, dredge spoil has been placed either at the head of Whitney Island, the downstream end of Beebe Island, or along the Illinois shore. Future disposal is expected to be at the Illinois shore site. Mussels were surveyed by brailing and hand collecting along Transect G in this proposed disposal area. In addition, exploratory sampling was conducted at Location H using qualitative techniques.

The main channel in the area of the future dredge cut (Transects B through D) had a medium grain sand substrate with current velocities averaging 1.9 ft/sec. Depth varied from 13 ft on the Missouri side to 16 ft on the

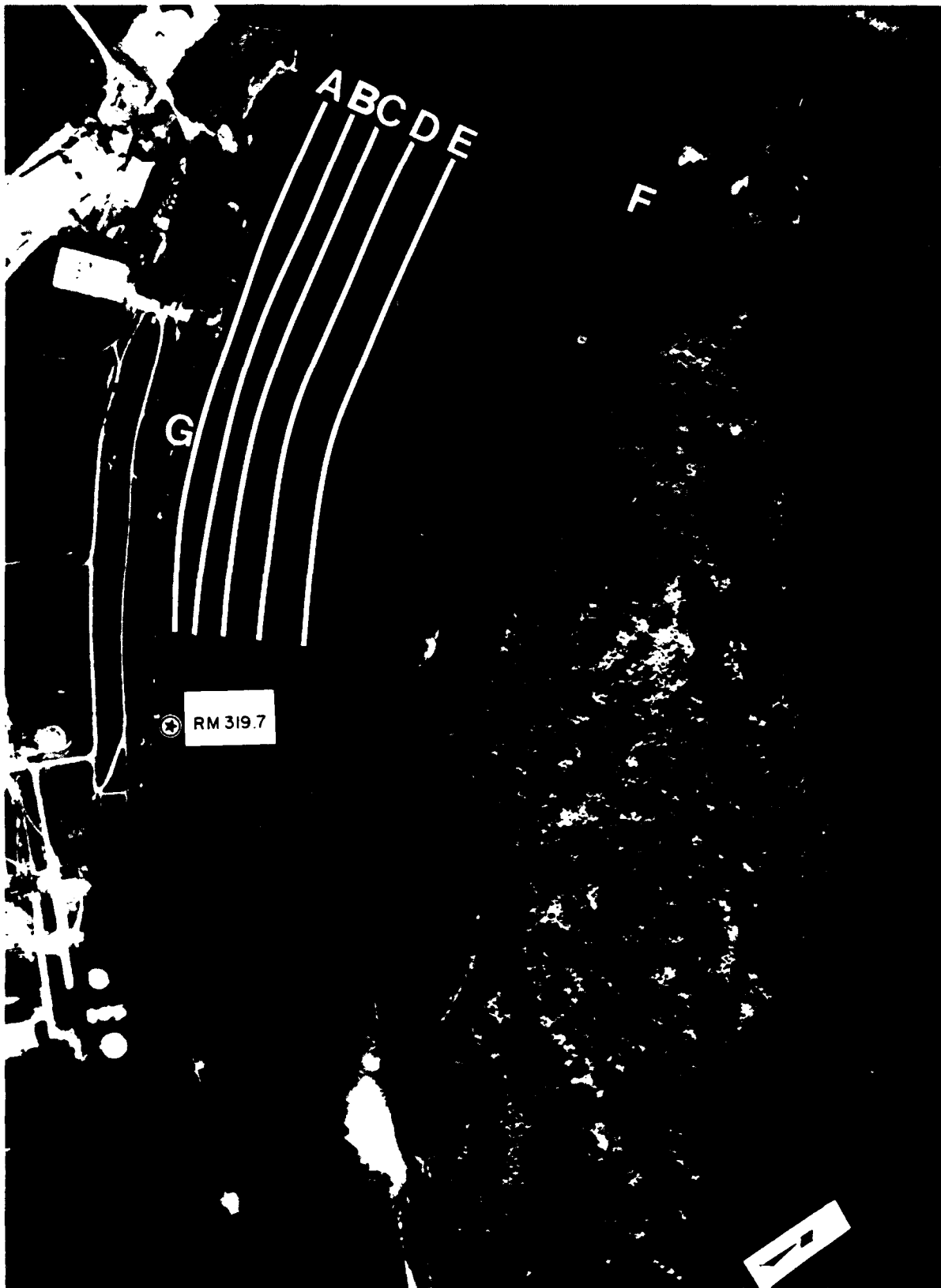


Figure 31. Collection locations near the Northeast Missouri Power Station site in Pool 22 of the Mississippi River (RM 319.8-320.5), October 1979.

Table 30. Freshwater mussels collected near the Northeast Missouri Power Station Site in Pool 22 of the Mississippi River (RM 319.8-320.5), October 1979.

Organism	Brail Transect <sup>a</sup>					Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINAE								
AMBLEMA PERUVIANA	3	0	0	0	0	4	0	7
FUSCONAIA UNDATA	2	0	0	0	0	1	1	4
MEGALONAIAS GIGANTEA	1	0	0	0	0	0	2	3
QUADRULA NODULATA	1	0	0	0	0	20	0	21
Q. PUSTULOSA	7	0	0	0	0	1	8	16
Q. QUADRULA	15	0	0	0	0	0	9	24
UNIONINAE								
ANODONTA CORPULENTA	0	0	0	0	0	1	0	1
LAMPSILIS ANODONTOIDES								
ANODONTOIDES	0	0	0	0	0	3	0	3
L. VENTRICOSA	0	0	0	0	0	9	1	10
LASMIGONA COMPLANATA	0	0	0	0	0	1	0	1
LEPTODEA FRAGILIS	1	0	0	0	0	2	0	3
L. LAEVISSIMA	0	0	0	0	0	12	0	12
OBLIQUARIA REFLEXA	1	0	0	0	0	8	6	15
OBOVARIA OLIVARIA	16	0	0	0	0	0	2	18
PLAGIOLA LINEOLATA	3	0	0	0	0	0	5	8
PROPTERA ALATA	0	0	0	0	0	2	0	2
TRUNCILLA DONACIFORMIS	0	0	0	0	0	1	0	1
T. TRUNCATA	0	0	0	0	0	1	0	1
TOTAL IN EACH SAMPLE	50	0	0	0	0	66	34	150

<sup>a</sup>Transect A, 3000 ft brail run, main channel border, historic and potential Missouri disposal site.

Transect B, 3000 ft brail run, main channel, dredge site.

Transect C, 3000 ft brail run, main channel, dredge site.

Transect D, 3000 ft brail run, main channel border, Illinois side.

Transect E, 3000 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location F, hand collecting, nearshore, Goose Island, historic disposal site.

Location G, miscellaneous qualitative collection, nearshore, historic and potential Missouri disposal site.

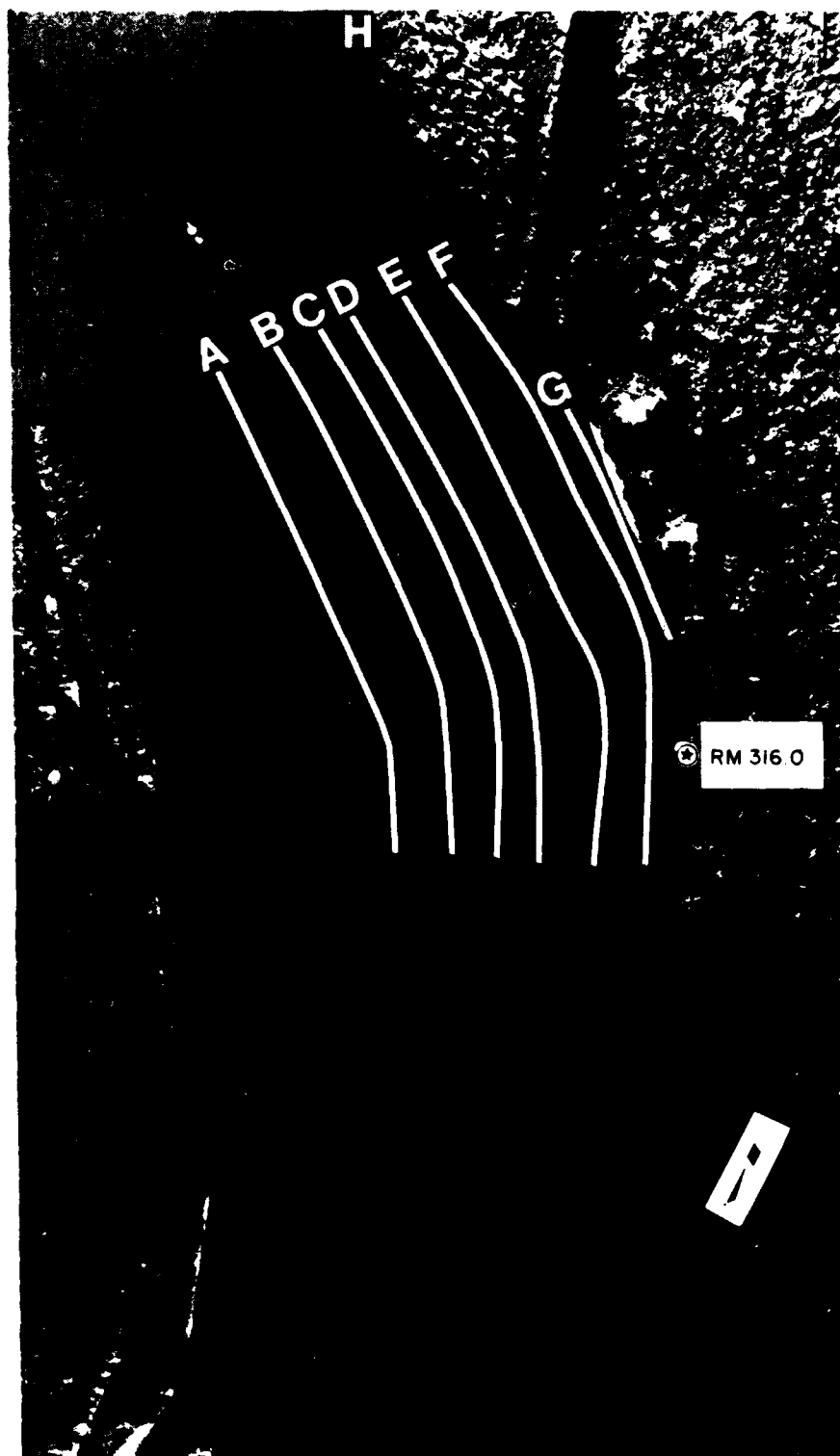


Figure 32. Collection locations near the Beebe Island Site in Pool 22 of the Mississippi River (RM 316.0-316.7), October 1979.

Table 31. Freshwater mussels collected near the Beebe Island Site in Pool 22 of the Mississippi River (RM 316.0-316.7), October 1979.

Organism	Brail Transect <sup>a</sup>						Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	H	
UNIONIDAE									
AMBLEMINAE									
AMBLEMA PERUVIANA	0	0	0	0	0	0	2	32	34
FUSCONAIA UNDATA	0	0	0	0	0	0	0	4	4
QUADRULA NODULATA	0	0	0	0	0	0	1	3	4
Q. PUSTULOSA	0	0	0	0	0	0	0	7	7
Q. QUADRULA	0	0	0	0	0	0	0	3	3
UNIONINAE									
ANODONTA CORPULENTA	0	0	0	0	0	0	0	4	4
A. IMBECILLIS	0	0	0	0	0	0	3	0	3
LAMPSILIS ANODONTOIDES									
ANODONTOIDES	0	0	0	0	0	0	0	1	1
L. VENTRICOSA	0	0	0	0	0	0	1	2	3
LEPTODEA LAEVISSIMA	0	0	0	0	0	0	5	18	23
OBLIQUARIA REFLEXA	0	0	0	0	0	0	0	7	7
OBOVARIA OLIVARIA	0	0	0	0	1	0	0	2	3
PROPTERA ALATA	0	0	0	0	0	0	0	1	1
TRUNCILLA DONACIFORMIS	0	0	0	0	0	0	0	3	3
T. TRUNCATA	0	0	0	0	0	0	0	1	1
TOTAL IN EACH SAMPLE	0	0	0	0	1	0	12	88	101

<sup>a</sup>Transect A, 3000 ft brail run, main channel border, Missouri side.

Transect B, 3000 ft brail run, main channel, dredge site.

Transect C, 3000 ft brail run, main channel, dredge site.

Transect D, 3000 ft brail run, main channel, dredge site.

Transect E, 3000 ft brail run, main channel border, Illinois side.

Transect F, 3000 ft brail run, main channel border, Illinois side.

<sup>b</sup>Location G, hand collecting and brail run, nearshore, Illinois side, historic and potential disposal site.

Location H, hand collecting, nearshore and slough, Illinois side, upstream from Beebe Island, exploratory site.

Illinois side. The substrate along the shore of the Whitney Island disposal was sand while the shoreline of the Illinois shore disposal area contained of the Illinois shore disposal area contained sand mixed with clay.

A sparse mussel fauna was observed at the Beebe Island Site during the October 1979 survey (Table 31). Only one individual of Obovaria olivaria was collected by brailing near the proposed dredge cut (Transects A through F). Near the Illinois shore disposal site (Location G), 12 mussels comprising five species were collected. Brailing and hand collecting near the Whitney Island historical disposal area yielded no mussels. The largest concentration of mussels was collected by raking along the shoreline and shallow backwater areas of Beebe Island (Location H). Eighty-eight specimens distributed among 14 species were collected. Amblema peruviana and Leptodea laevis were the dominant species in this assemblage. Included in this collection was one specimen of the uncommon, Lampsilis anodontoides. No Endangered species were collected during the survey of the Beebe Island Site; however, relic valves of Proptera capax were observed at the upstream end of Beebe Island.

Perry (1979) found a diverse assemblage of mussels immediately downstream from the Beebe Island Site during 1976. While brailing 25 yards from the Illinois shoreline at RM 315.1-316.0, he collected 15 species of mussels including the rarely collected Fusconaia ebenus. Perry suggested that sand had been drifting downstream, perhaps from the area of the Beebe Island Site, and was covering upper portions of this bed. Brailing by Ecological Analysts, Inc. (1981d) along the east shore of Whitney Island at RM 314.0-315.0 yielded no mussels.

Mussels were sparse near the Beebe Island Site. In addition, no Endangered or other special status species have been collected in any recent surveys. It is doubtful that dredging will have an appreciable impact on mussels within or near the area of the proposed cut. Immediately downstream of the Beebe Island Site along the Illinois shore, however, a diverse mussel community was encountered. These mussels probably will not be affected by the future dredge cut, but may be influenced by future spoil disposal along the Illinois shore. Precautions should be taken to insure this mussel assemblage is not adversely affected by dredge spoil encroachment or excessive sedimentation.

### 3.12.4 Turtle Island Site

The Turtle Island Site is situated 13 miles downstream from Lock and Dam 21 just upstream from Hannibal, Missouri. Channel maintenance occurred at this site six times from 1956 through 1973 (USACOE 1974). Transects B, C, D, and E, each 2,500-ft brail runs, were established in the area of the dredge cut (Figure 33). The dredge spoil during previous maintenance operations was placed along the east shoreline of Ziegler Island (near Transect A), and along the west banks of Turtle Island and the smaller island upstream of Turtle Island (near Transect F). Future disposal probably will continue at each of these sites. Transect A and F (each 2,500-ft brail runs) and Location G and H were established to assess mussels near these probable disposal areas (Figure 33).

Substrates of the channel and channel border habitats in the Turtle Island Site were predominantly sand. A clay and silt river bottom was found in still-water areas at the upstream and downstream ends of Turtle Island. Sand accretion had resulted in shallower depths (10 to 13 feet) in the Missouri portion of the main channel than in the Illinois portion of the main channel (18 to 19 feet).

Fourteen species of mussels representing a total of 66 individuals were collected in the survey of the Turtle Island Site during June and August 1980 (Table 32). Brailing near the disposal sites and the main channel yielded few mussels (Transects A through F); however, pollywogging and raking at the upstream and downstream tips of Turtle Island (Location G) produced numerous mussels. Amblema peruviana and Obliquaria reflexa were the dominant species in these collections. Only three mussels were observed in hand collecting along the Ziegler Island shoreline disposal area (Location H, Table 32). No Endangered or special status species were observed at this dredge site during 1980.

This portion of Pool 22 has been investigated by numerous researchers. Pollywogging in three areas near Turtle Island by Ostdiek et al. (1980) yielded 64 specimens of Amblema peruviana. A single individual of Quadrula quadrula was the only other species reported by these authors in their 1980 collections. Brailing was conducted immediately downstream from the Turtle Island dredge site by Ostdiek et al. (1980) and 11 individuals (primarily A. peruviana) were collected in four brail runs. Perry (1979), during 1976, also conducted brail runs along the shore of Turtle Island and along the lower end of Ziegler Island. The only mussels he collected were O. reflexa and Q. quadrula near Ziegler Island. Upstream from the Turtle Island Site near Whitney and Armstrong Islands (RM 312.9-314.4), Freitag (1978) reported 48 live mussels comprising eight species. Pollywogging at the downstream end of Whitney Island yielded the greatest number of mussels, especially A. peruviana and Q. quadrula. No Endangered or special status species were reported in any of these recent surveys.

Ellis' survey of 1930-1931 (van der Schalie and van der Schalie 1950) recorded 15 species of mussels approximately two miles downstream from the Turtle Island Site, near Hannibal, Missouri. Numerous individuals of the presently uncommon species Lampsilis anodontoides anodontoides and Endangered species Proptera capax were collected. Live P. capax have not been reported from any recent surveys of the Mississippi River.

Future channel maintenance activity probably will have little impact on the mussel fauna near the Turtle Island Site. No Endangered species have been encountered in the recent surveys of this area and the fauna of the channel and channel border habitats was sparse. Mussels were relatively abundant, however, at the upstream and downstream ends of Turtle Island. Future dredge spoil should be placed either on Ziegler Island or near the middle section of Turtle Island to avoid affecting adversely this fauna.



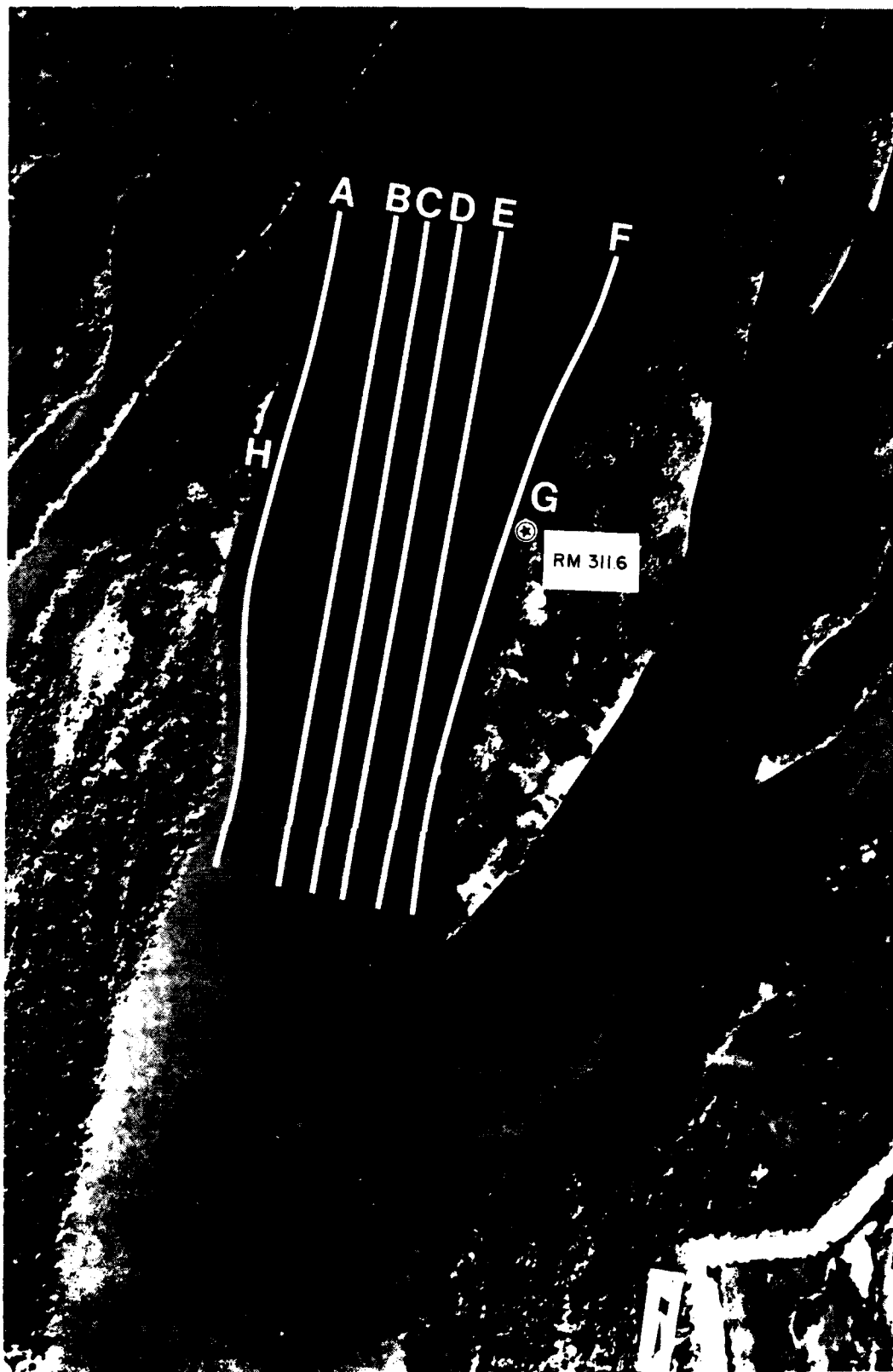


Figure 33. Collection locations near the Turtle Island Site in Pool 22 of the Mississippi River (RM 311.1-311.9), June and August 1980.

Table 32. Freshwater mussels collected near the Turtle Island Site in Pool 22 of the Mississippi River (RM 311.1-311.9), June and August 1980.

Organism	Brail Transect <sup>a</sup>						Other <sup>b</sup>		Total Mussels
	A	B	C	D	E	F	G	H	
UNIONIDAE									
AMBLEMINAE									
AMBLEMA PERUVIANA	0	0	0	0	0	0	28	0	28
FUSCONAIA UNDATA	0	0	0	0	0	0	2	0	2
QUADRULA NODULATA	0	0	0	0	0	0	1	0	1
Q. PUSTULOSA	0	0	0	0	0	0	1	0	1
UNIONINAE									
ANODONTA CORPULENTA	0	0	0	0	0	0	1	0	1
A. IMBECILLIS	0	0	0	0	0	0	1	0	1
LAMPSILIS VENTRICOSA	0	0	0	0	0	0	3	0	3
LEPTODEA FRAGILIS	0	0	0	0	0	1	2	0	3
L. LAEVISSIMA	0	0	0	0	0	0	1	1	2
OBLIQUARIA REFLEXA	0	0	0	0	0	0	13	0	13
OBOVARIA OLIVARIA	0	0	0	0	0	0	1	0	1
PROPTERA ALATA	0	0	0	0	0	0	3	0	3
TRUNCILLA DONACIFORMIS	0	0	0	0	0	1	2	2	5
T. TRUNCATA	0	0	0	0	0	0	2	0	2
TOTAL IN EACH SAMPLE	0	0	0	0	0	2	61	3	66

- <sup>a</sup>Transect A, 2500 ft brail run, nearshore, historic and potential Missouri disposal site.  
 Transect B, 2500 ft brail run, main channel border, Missouri side.  
 Transect C, 2500 ft brail run, main channel, dredge site.  
 Transect D, 2500 ft brail run, main channel, dredge site.  
 Transect E, 2500 ft brail run, main channel border, Illinois side, dredge site.  
 Transect F, 2500 ft brail run, nearshore, historic and potential Illinois disposal site.
- <sup>b</sup>Location G, hand collecting, nearshore, historic and potential Illinois disposal site, Turtle Island.  
 Location H, hand collecting, nearshore, historic and potential Missouri disposal site, Ziegler Island.



Figure 34. Collection locations near the Lock and Dam 22 Lower Approach Site in Pool 24 of the Mississippi River (RM 299.8-301.1), October 1979.

Table 33. Freshwater mussels collected near the Lock and Dam 22 Lower Approach Site in Pool 24 of the Mississippi River (RM 299.8-301.1), October 1979.

Organism	Brail Transect <sup>a</sup>						Other <sup>b</sup>	Total Mussels
	A	B	C	D	E	F	G	
UNIONIDAE								
AMBLEMINAE								
AMBLEMA PERUVIANA	17	0	0	0	0	10	60	87
FUSCONAIA UNDATA	4	0	0	0	0	5	1	10
MEGALONAIAS GIGANTEA	14	0	0	0	0	7	0	21
QUADRULA METANEVRA	1	0	0	0	0	0	0	1
Q. NODULATA	2	0	0	0	0	0	13	15
Q. PUSTULOSA	4	0	0	0	0	2	4	10
Q. QUADRULA	4	0	0	0	0	5	8	17
UNIONINAE								
ANODONTA CORPULENTA	0	0	0	0	0	0	3	3
LAMPSILIS ANODONTOIDES								
ANODONTOIDES	0	0	0	0	0	0	1	1
L. VENTRICOSA	0	0	0	0	0	3	6	9
LEPTODEA LAEVISSIMA	0	0	0	0	0	0	8	8
OBLIQUARIA REFLEXA	4	0	0	0	0	5	7	16
OBOVARIA OLIVARIA	3	1	0	0	0	0	0	4
PLAGIOLA LINEOLATA	1	0	0	0	0	2	0	3
PROPTERA ALATA	0	0	0	0	0	2	0	2
TRUNCILLA DONACIFORMIS	0	0	0	0	0	0	1	1
T. TRUNCATA	1	0	0	0	0	0	0	1
TOTAL IN EACH SAMPLE	55	1	0	0	0	41	112	209

<sup>a</sup>Transect A, 4000 ft brail run, main channel border, Missouri side, historic and potential disposal site.

Transect B, 4000 ft brail run, main channel, dredge site.

Transect C, 4000 ft brail run, main channel, dredge site.

Transect D, 4000 ft brail run, main channel, dredge site.

Transect E, 4000 ft brail run, main channel border, Illinois side.

Transect F, brail runs, nearshore, Missouri side, downstream from historic and potential disposal site.

<sup>b</sup>Location G, hand collecting, nearshore, Illinois side, west side of Cottel Island, exploratory site.

### 3.13 POOL 24

#### 3.13.1 Lock and Dam 22 Lower Approach Site

The lower approach to Lock and Dam 22 was the only area in Pool 24 in which mussels were surveyed relative to potential channel maintenance dredging and spoil disposal. The potential dredge cut extends from the lock wall, downstream approximately one-half mile. Transects B, C, D, and E (each 4,000-ft brail runs), were sampled for mussels in the main channel and channel border in the area of the potential dredge cut (Figure 34). Future spoil material is expected to be placed immediately adjacent to the dredge cut along the Missouri shore. Brailing Transects A and F were established to assess mussels in the vicinity of this historic and potential spoil disposal site (Figure 34). In addition, exploratory sampling, utilizing qualitative techniques, was conducted along Cattel Island (Location G).

The substrate in the main channel area was predominantly medium grain sand mixed with minor amounts of rubble. Along the Missouri shore and just below the lock approach primarily rubble substrates were encountered. Flat pool depth of the main channel was 11 to 13 feet. Depth decreased to approximately 8 feet in the border area along the Missouri shore.

A total of 17 mussel taxa were collected at the Lock and Dam 22 Lower Approach Site during October 1979 (Table 33). Main channel brailing runs in the area of the potential dredge cut (Transects B, C, and D) yielded only one individual (Table 33). No mussels were collected from the channel border area along the Illinois side. The main channel border area on the Missouri side yielded 11 taxa (Transect A). Amblema peruviana and Megalonaias gigantea were the dominant mussels collected. Densities were greatest (37 mussel/500-ft run) at the lower end of the transect immediately downstream of a small rocky peninsula. These two taxa were also the most abundant species recorded from brailing runs along the Missouri shore downstream of the disposal site at Transect F.

Hand picking and raking along Cattel Island on the Illinois side (Location G) yielded 11 taxa and 112 mussels (Table 33). Approximately half of the specimens were A. peruviana that were collected from a sand flat at the south end of the island. Quadrula nodulata and Quadrula quadrula were abundant in this same sand flat area. At the northern end of Cattel Island, Lampsilis ventricosa was the dominant species collected. Although no Endangered or special status species were collected, one individual of the uncommon Yellow Sandshell, Lampsilis anodontoides anodontoides, and three relic valves of the Endangered Proptera capax were encountered at the south end of Cattel Island.

Perry (1979) provided the only recent mussel data from this area of Pool 24. He reported the collection of relic valves of L. a. anodontoides and five other taxa from the Missouri shore in the area of Location F. During 1978, Freitag (1978) surveyed a dredge site immediately upstream from Lock and Dam 22. Extensive brailing in this area of Pool 22 yielded only four mussels representing three species.

#### 4.0 SPECIES SUMMARIES

Thirty-five pelecypod taxa were collected in this 1979-1980 survey of Pools 11 through 24 of the Mississippi River (Table 34). Within the following pages, the occurrence of each taxon in the 1979-1980 survey is discussed individually and available autecological information relating to habitat preferences and historical trends in abundance is summarized. Throughout the species summaries, several comparisons are made between the present survey and data from surveys of Ellis in 1930-1931 (van der Schalie and van der Schalie 1950), the Upper Mississippi River Conservation Committee (UMRCC) in 1975-1976 (Perry 1979), and the Philadelphia Academy of Sciences in 1977 (Fuller 1978). These three mussel investigations provide the most extensive historic and modern information of the Mississippi River mussel fauna. However, these surveys were biased for selected habitats and may not reflect an accurate description of the entire Upper Mississippi River mussel fauna. The surveys by Ellis and Perry concentrated in the main channel and channel border areas and did not adequately sample the backwater areas. The survey by Fuller and the present investigation were restricted primarily to channel maintenance sites. The species information presented in this report is primarily representative of dredging areas in the Rock Island District of the Mississippi River and should not be interpreted as being characteristic of the entire Upper Mississippi River.

Within each species summary, the survival rankings assigned to each species by Fuller (1980) are reviewed relative to the findings of the present study. Fuller's rankings included four categories; Endangered, Jeopardized, Troubled, or Healthy. Endangered species are federally-listed, nationally protected species that are in danger of extinction throughout much or all of their natural ranges. Jeopardized mussels face extirpation in the Upper Mississippi River (UMR) for one or more reasons, including commercial harvesting, declining water quality, impoundment effects (especially streambed change), and unavailability of definitive glochidial hosts. Troubled species were characterized by a reduction in either their densities and/or geographic range. Each Troubled species in the UMR has experienced either reduced numbers or range but each continues to exhibit some evidence of reproduction and recruitment. The historical quantity and/or geographic range of most Healthy species in the UMR also have been reduced, but each continues to thrive locally, and a few appear to be exploiting impoundment conditions.

Species summaries are presented in two subsections. The first subsection addresses the Special Status Species encountered and the second subsection addresses, in decreasing order of abundance, the remaining species collected.

##### 4.1 SPECIAL STATUS SPECIES

A principal concern of this mussel survey in the USACOE Rock Island District was to determine the distribution and abundance of special status mussel species relative to proposed channel maintenance dredging and spoil disposal. Special status species include: 1) mussels which are now listed as federally protected Endangered species; 2) mussels under Notice of Review for possible addition to the U.S. List of Endangered and Threatened Wildlife and Plants; or 3) rare species which may occur in the Mississippi River. The nationally

Table 34. Scientific and common names of the pelecypods collected from the Upper Mississippi River in 1979 and 1980.

Scientific Name	Common Name
<b>Corbiculidae</b>	
<u>Corbicula fluminea</u> (Muller)	Asiatic Clam
<b>Margaritiferidae</b>	
<b>Cumberlandiinae</b>	
<u>Cumberlandia monodonta</u> (Say)	Spectacle Case
<b>Unionidae</b>	
<b>Ambleminae</b>	
<u>Amblema peruviana</u> (Lamarck)	Three-ridge
<u>Fusconaia ebenus</u> (Lea)	Ebony Shell
<u>F. undata</u> (Barnes)	Pig-toe
<u>Megalonaia gigantea</u> (Barnes)	Washboard
<u>Quadrula metanevra</u> (Rafinesque)	Monkey-face
<u>Q. nodulata</u> (Rafinesque)	Warty-back
<u>Q. pustulosa</u> (Lea)	Pimple-back
<u>Q. quadrata</u> Rafinesque	Maple-leaf
<b>Unioninae</b>	
<u>Actinonaias carinata</u> (Barnes)	Mucket
<u>Anodonta corpulenta</u> Cooper	Stout Floater
<u>A. imbecillis</u> Say	Paper Pond Shell
<u>A. suborbiculata</u> Say	Flat Floater
<u>Arcidens confragosus</u> (Say)	Rock Pocketbook
<u>Carunculina parva</u> (Barnes)	Lilliput Shell
<u>Elliptio dilatatus</u> (Rafinesque)	Spike
<u>Lampsilis anodontoides anodontoides</u> (Lea)	Yellow Sandshell
<u>L. a. fallaciosa</u> (Smith)	Slough Sandshell
<u>L. higginsii</u> (Lea)	Higgins' Eye
<u>L. radiata siliquioidea</u> (Barnes)	Fat Mucket
<u>L. ventricosa</u> (Barnes)	Pocketbook
<u>Lasmigona complanata</u> (Barnes)	White Heel-splitter
<u>Leptodea fragilis</u> (Rafinesque)	Fragile Paper-shell
<u>L. laevissima</u> (Lea)	Pink Paper-shell
<u>Ligumia recta latissima</u> Rafinesque	Black Sandshell
<u>Obliquaria reflexa</u> (Rafinesque)	Three-horned Warty-back
<u>Obovaria olivaria</u> (Rafinesque)	Hickory-nut
<u>Plagiola lineolata</u> (Rafinesque)	Butterfly
<u>Plethobasus cyphus</u> (Rafinesque)	Bullhead
<u>Pleurobema cordatum</u> (Rafinesque)	Ohio Pig-toe
<u>Proptera alata</u> (Say)	Pink Heel-splitter
<u>Strophitus undulatus</u> (Say)	Strange Floater
<u>Truncilla donaciformis</u> (Lea)	Fawn's Foot
<u>T. truncata</u> (Rafinesque)	Deer-toe

Endangered species Lampsilis higginsii, Lampsilis orbiculata and Proptera (=Potamilus) capax; the species under Notice of Review Cumberlandia monodonta and Leptodea leptodon; and the rarely collected species Simpsoniconcha ambigua are mussels which have been recorded in this region of the Mississippi River and qualify as special status species. During this survey, live specimens of L. higginsii and C. monodonta were observed at several sites. Only relic shells of P. capax were observed in this investigation of the Mississippi River mussel fauna. This section describes, in detail, the occurrence of these special status species in the Rock Island District of the Mississippi River. No evidence of the other special status species was found in 1979-1980.

#### 4.1.1 Lampsilis higginsii (Higgins' Eye)

Eight individuals of the federally Endangered Lampsilis higginsii were collected in the present survey (Table 35). Single individuals were collected from three dense commercial mussel beds in Pools 14, 16 and 17 and five individuals were collected from areas with moderate mussel concentrations in Pools 11 and 14. The present survey determined that Pool 14 contained a relatively large population of the Endangered L. higginsii, particularly at the Steamboat Slough Site (RM 503.2-504.1). In addition to the four Higgins' Eye collected at this station in 1980, 12 individuals were observed immediately upstream from this site in 1976 (Lewis and Brice 1977) and 1977 (Lewis 1979).

Lampsilis higginsii has been reported from a wide variety of habitats. In this survey, L. higginsii was collected from habitats ranging from gravelly deep water areas with dense mussel concentrations to shallow sandy areas with sparse mussel densities. Marsh (1887-1889) collected this species from deep water near the channel. Nelson and Freitag (1980) indicated that most recent collections of L. higginsii were in mussel beds with mud, sand and gravel substrates and depths of 8 to 30 feet. The present survey and data of Nelson and Freitag suggest that a continuous river current is the single most important environmental factor influencing the occurrence of L. higginsii.

Lampsilis higginsii has apparently been an uncommon species in the Mississippi River since the late 1800s. Early surveys by Marsh (1887-1889), Baker (1905) and Coker (1919) all reported the Higgins' Eye to be an uncommon or rare mussel in the Mississippi River. Ellis also reported that the species constituted only a small percentage (0.04%) of the mussel fauna during his 1930-1931 survey (van der Schalie and van der Schalie 1950). Nelson and Freitag (1980) summarized the occurrence of Higgins' Eye in the Mississippi River since 1966. These authors also noted that the species was rare and reported a total collection of 25 individuals from 14 sites encompassing Pools 7 through 17. Based upon the data of Nelson and Freitag (1980), the collection of L. higginsii at Jonas Johnson Island (RM 438.7) in the present study represented the southernmost record for the species in the Mississippi River since 1966.



Table 35. Summary of past and present freshwater mussel occurrence in the Upper Mississippi River, 1930-1931, 1977 and 1979-1980.

Taxon	1979-1980 <sup>a</sup>			1930-1931 <sup>b</sup>	1977 <sup>c</sup>
	Site Occurrences	No.	%	%	%
<i>Amblema peruviana</i>	29	2948	30.36	6.91	34.68
<i>Quadrula pustulosa</i>	29	1397	14.39	4.98	9.07
<i>Fusconaia undata</i>	28	850	8.75	5.01	3.29
<i>Obovaria olivaria</i>	30	626	6.45	5.61	5.43
<i>Megalonaia gigantea</i>	17	580	5.97	1.17	2.64
<i>Quadrula quadrula</i>	27	541	5.57	4.06	6.26
<i>Lampsilis ventricosa</i>	27	404	4.16	4.04	1.07
<i>Obliquaria reflexa</i>	29	320	3.30	3.22	3.05
<i>Truncilla donaciformis</i>	25	266	2.74	3.17	14.20
<i>Leptodea laevis</i>	29	259	2.67	2.80	0.78
<i>Plagiola lineolata</i>	16	220	2.27	0.41	0.48
<i>Anodonta corpulenta</i>	27	180	1.85	3.12	1.94
<i>Quadrula nodulata</i>	22	166	1.71	1.51	4.03
<i>Leptodea fragilis</i>	20	165	1.70	10.10	1.27
<i>Proptera alata</i>	23	149	1.53	3.75	1.38
<i>Truncilla truncata</i>	21	149	1.53	1.13	2.65
<i>Actinonaias carinata</i>	9	111	1.14	0.71	0.35
<i>Quadrula metanevra</i>	13	100	1.03	2.61	0.30
<i>Corbicula fluminea</i>	11	81	0.83		
<i>Arcidens confragosus</i>	10	52	0.54	0.10	0.57
<i>Ligumia recta latissima</i>	11	32	0.33	0.67	0.24
<i>Carunculina parva</i>	8	28	0.29	0.09	2.36
<i>Anodonta imbecillis</i>	13	27	0.28	2.62	2.11
<i>Lasmigona complanata</i>	7	13	0.13	0.88	0.13
<i>Lampsilis anodontoides anodontoides</i>	5	9	0.09	2.06	d
<i>Plethobasus cyphus</i>	3	9	0.09	0.12	
<i>Lampsilis higginsii</i>	4	8	0.08	0.04	0.01
<i>Strophitus undulatus</i>	5	6	0.06	0.97	0.18
<i>Fusconaia ebenus</i>	2	5	0.05	3.56	
<i>Lampsilis radiata siliquoidea</i>	2	3	0.03	4.82	0.08
<i>Cumberlandia monodonta</i>	2	2	0.02		0.08
<i>Anodonta suborbiculata</i>	1	1	0.01		
<i>Elliptyio dilatatus</i>	1	1	0.01	1.98	1.08
<i>Lampsilis anodontoides fallaciosa</i>	1	1	0.01	11.75	d
<i>Pleurobema cordatum</i>	1	1	0.01	0.14	0.03
<i>Actinonaias elliptiformis</i>				0.10	
<i>Alasmodonta marginata</i>				0.06	
<i>Cyclonaias tuberculata</i>				0.03	
<i>Elliptyio crassidens</i>				0.01	0.01
<i>Proptera canax</i>				0.68	
<i>Simpsoniconcha ambigua</i>				0.01	
<i>Tritogonia verrucosa</i>				4.98	
TOTAL MUSSELS		9710			
TOTAL TAXA		35		39	31

<sup>a</sup>Survey by Ecological Analysts, Inc.

<sup>b</sup>Survey by M. M. Ellis (van der Schalie and van der Schalie 1950).

<sup>c</sup>Survey by Philadelphia Academy of Science (Fuller 1978).

<sup>d</sup>These two forms were not separated; the species *Lampsilis anodontoides* made up 0.23% of the fauna.

The status of this species in the Upper Mississippi River is uncertain. Lampsilis higginsii is presently, and has always been, considered a rare or uncommon species. However, Havlik (1980) indicates that based on 1977-1980 records, the range of L. higginsii in the Upper Mississippi River has decreased by 52.5% from its historic distribution. Fuller (1980) indicated that the excessive commercial mussel harvesting early in this century in conjunction with deteriorating water quality may have led toward the extirpation of this species from the Mississippi River. The present study, however, suggests the abundance of L. higginsii is currently similar to densities recorded in Ellis' 1930-1931 survey, and identifies relatively large population densities in Pool 14. In addition, two young males (46 and 58 mm in length, both 4-5 years old) collected in the present survey and a young male (49 mm in length, 4-5 years old) collected by Freitag in 1979 (USFWS 1980) suggests the occurrence of recruitment in this pool.

#### 4.1.2 Proptera capax (Fat Pocketbook)

No live individuals of Proptera capax were observed in this 1979-1980 survey of the Upper Mississippi River. Relic valves, however, were collected at five sites in the lower portion of the Rock Island District (Pools 20 through 24). Collection effort was intensified at these sites to locate live P. capax but sampling was unproductive.

The ecological requirements of P. capax in the Mississippi are not fully known because of its uncommon occurrence in early surveys and absence in recent studies. Marsh (1887-1889) reported the Fat Pocketbook to be an active species in shallow sandy habitats of the Mississippi River. Parmalee (1967) described P. capax as a large river species found on sand and mud bottom, in flowing water, and at depths from a few inches to eight feet or more. In the Mississippi River, Baker (1928) found this species on a mud bottom. Apparently this thin-shelled mussel prefers a substrate with fine grain particles.

The Fat Pocketbook was considered rare in the Mississippi River prior to 1900 (Witter 1883; Marsh 1887-1889; Keyes 1889). As recent as the 1930-1931 Ellis survey, P. capax was considered uncommon but widely distributed in the Upper Mississippi River (van der Schalie and van der Schalie 1950). The Ellis survey indicated this species was more abundant in the southern portion of the Upper Mississippi River. Baker (1928) also described P. capax as a species of southern distribution and rare north of Davenport, Iowa. Relic valves recently collected in Pool 19 by Freitag (USFWS 1980) and Pogge and Schneider (1980), in Pool 22 by Freitag (1978), in Pool 24 by Oesch (Perry 1979), and in Pools 20 through 24 during the present survey further substantiate the southern distribution of this species.

Surveys of the Mississippi River since 1966 have failed to collect any live P. capax (Nelson and Freitag 1980), indicating this species may have been extirpated from the Upper Mississippi River or is extremely rare. Most recent surveys, however, have been restricted to channel and channel border habitats. Future sampling in backwater areas, perhaps the extensive lentic habitat of Pool 19, may reveal a population of P. capax.

#### 4.1.3 Cumberlandia monodonta (Spectacle Case)

Two individuals of the special status species Cumberlandia monodonta were collected in the Rock Island District during 1979-1980 (Table 35). These individuals were collected in commercial mussel beds with a silty and sandy gravel substrate at depths from 10 to 15 feet. Nelson and Freitas (1980) reported the Mississippi River collections of C. monodonta since 1966 have been from mussel beds in substrates including rubble, rock, gravel, sand, mud and silt at depths of 6 to 16 feet. Ecological Analysts, Inc. (1981a) collected numerous C. monodonta in Pool 15 in 1980 in shallow areas (3 to 4 feet) from silt and clay pockets in predominantly rubble substrates. Fuller (1978) also reported C. monodonta within recesses among boulders and in spaces beneath rocks that are in loose contact with the riverbed.

In recent years the southernmost collection of the Spectacle Case in the Mississippi River was reported immediately upstream from Lock and Dam 19 in a substrate of concrete pieces and gravel, moderately fast current and a depth of 34 feet (Bindel 1979).

This species' preference for a rubble substrate probably has restricted its range and density in the Upper Mississippi River. The present range of C. monodonta in Pools 15 through 19 is a portion of the Mississippi River which historically provided extensive rubble substrate. Since the completion of the lock and dam system, this substrate is now uncommon in the pools of the Mississippi River. Wing dams have been suggested as a favorable habitat for the Spectacle Case (Fuller 1978); however, pollywogging on several wing dams in this survey did not yield any C. monodonta.

This species was considered very rare in early Mississippi River surveys by Marsh (1887-1889) and Baker (1905), and was not collected in the intensive 1930-1931 survey of the river by Ellis (van der Schalie and van der Schalie 1950). Fuller (1978) collected six individuals of C. monodonta in Pool 19 during his 1977 survey. In addition, Stanley Consultants, Inc. (1980) brailled four individuals of this species in Pool 17 (RM 453) during a 1980 survey. Most recent surveys, however, have indicated the Spectacle Case is an extremely rare species. The infrequent reports of live individuals may be attributed, in part, to difficulties in brailing this deep burrowing species in rubble substrates. Hand collections by divers have disclosed greater densities of C. monodonta than were previously recorded. Intensive mussel relocation projects utilizing divers at a mussel bed in Pool 15 yielded 16 individuals in 1979 (NUS Corp. 1979) and 12 in 1980 (Ecological Analysts, Inc. 1981a).

Fuller (1980) classified the status of the Spectacle Case in the Mississippi River as Troubled. He regarded the destruction of preferred habitat by impoundments as the reason for its rareness in the river. Although recent surveys indicate a greater abundance of C. monodonta than was previously reported, this species remains a rare mussel in the Mississippi River. Further research is needed on C. monodonta to clarify the status of its reproductive success in the river and to discover its glochidial host.

## 4.2 OTHER SPECIES

### 4.2.1 Amblema peruviana (Three-ridge)

Amblema peruviana was the dominant mussel species encountered during the 1979-1980 survey in the Rock Island District of the Mississippi River. This species constituted 30.36% of the total collection (Table 35). In the present survey, A. peruviana was the numerically dominant mussel in most pools (Table 36) and occurred at 29 of the 32 sites. During this survey, the Three-ridge was commonly found in a variety of habitats, including shallow lentic areas with fine substrates and deep channel border habitats with gravel bottoms. This commercially valuable species was always abundant in mussel beds and occasionally very common in silty backwater areas.

Relative abundance of this species has increased substantially since 1930-1931 when it composed only 6.91% of the mussel fauna in this section of the Mississippi River (Table 35). The Three-ridge was also the dominant taxon (34.68%) in the 1977 survey of the Upper Mississippi River by Fuller (1978). The Three-ridge has, historically, been considered common to abundant in the Mississippi River (Witter 1883; Marsh 1887-1889; Baker 1905), but in early studies it never dominated the fauna as it presently does. The success of this species has been attributed to its varied glochidial fish hosts, tolerance of poor water quality and utilization of a variety of substrates (Fuller 1978). The creation of the present pool system and extensive silty backwater areas probably was favorable for A. peruviana populations.

The varied size class distribution of A. peruviana in the present survey indicated successful reproduction and recruitment of this species in the Mississippi River (Figure 35). Length measurements of A. peruviana and all other taxa encountered in this survey are summarized by pools in Appendix A. Young specimens (<40 mm in length and 1-5 years old) were encountered in most pools of the river. Fuller (1980) categorized the Three-ridge population in the Mississippi River as Healthy. The apparent successful reproduction of A. peruviana and its increased relative abundance since 1930-1931 supported Fuller's Healthy classification.

### 4.2.2 Quadrula pustulosa (Pimple-back)

Quadrula pustulosa was the second most frequently collected species in this survey and composed 14.39% of the fauna (Table 35). The Pimple-back was present at 29 of the 32 sites investigated and was common to abundant in all pools (Table 36). In the present study, Q. pustulosa was one of the most abundant species colonizing the silty and sandy gravel substrate at Big Timbers and New Boston mussel bed sites (Tables 17 and 19, respectively). Quantitative diver-sampling at these sites revealed the Pimple-back was the numerically dominant species and not A. peruviana as the trail runs in the same area had indicated. Quadrula pustulosa densities at these sites averaged 24.3 individuals/m<sup>2</sup>, compared to 12.6/m<sup>2</sup> for A. peruviana. Shallow channel-border areas with stable sand and silty sand substrates also yielded numerous Pimple-backs. Parmalee (1967) reported this species was able to adapt to a variety of substrates and depths.

Table 16. Number and percent occurrence of freshwater mussels in Pools 11 through 24 of the Upper Mississippi River, 1972-1980.

Taxon	11		12		13		14		15		16	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<i>Unionidae</i>												
<i>Corbicula fluminea</i>	228	(21.0)	8	(4.8)	158	(18.7)	50	(4.8)	8	(2.0)	109	(6.8)
<i>Margaritifera</i>	4	(0.4)	20	(12.1)	3	(0.4)	14	(1.3)	16	(4.1)	68	(4.7)
<i>Unionidae</i>	1	(0.1)	3	(0.2)	2	(0.2)	3	(0.3)	2	(0.5)	12	(0.5)
<i>Unionidae</i>	7	(0.6)	3	(1.8)	3	(0.4)	50	(4.8)	22	(5.6)	10	(0.5)
<i>Q. pustulosa</i>	47	(4.3)	6	(3.6)	23	(2.7)	168	(16.1)	26	(19.4)	267	(16.7)
<i>Q. quadrula</i>	40	(3.7)	13	(7.9)	66	(7.9)	40	(3.9)	10	(2.6)	41	(2.9)
<i>Unionidae</i>												
<i>Ambleminae</i>												
<i>Amblema peruviana</i>	413	(38.0)	30	(18.2)	203	(24.0)	433	(41.6)	177	(45.2)	532	(33.3)
<i>Fusconaia ebena</i>	228	(21.0)	8	(4.8)	158	(18.7)	50	(4.8)	8	(2.0)	109	(6.8)
<i>Megalomias gigantea</i>	4	(0.4)	20	(12.1)	3	(0.4)	14	(1.3)	16	(4.1)	68	(4.7)
<i>Quadrula metanevra</i>	1	(0.1)	3	(0.2)	2	(0.2)	3	(0.3)	2	(0.5)	12	(0.5)
<i>Q. nodulata</i>	7	(0.6)	3	(1.8)	3	(0.4)	50	(4.8)	22	(5.6)	10	(0.5)
<i>Q. pustulosa</i>	47	(4.3)	6	(3.6)	23	(2.7)	168	(16.1)	26	(19.4)	267	(16.7)
<i>Q. quadrula</i>	40	(3.7)	13	(7.9)	66	(7.9)	40	(3.9)	10	(2.6)	41	(2.9)
<i>Unionidae</i>												
<i>Actinonaias carinata</i>	15	(1.4)	2	(1.2)	11	(1.3)	56	(5.4)	3	(0.8)	34	(2.1)
<i>Anodonta corpulenta</i>	4	(0.4)	P		4	(0.5)	4	(0.4)	1	(0.3)	27	(1.7)
<i>A. imbecilis</i>												
<i>A. suborbiculata</i>	3	(0.3)	1	(0.6)			1	(0.1)			1	(0.1)
<i>Arcidens confragosus</i>	15	(1.4)					4	(0.4)			7	(0.4)
<i>Carunculina parva</i>	1	(0.1)									1	(0.1)
<i>Flititio dilatatus</i>												
<i>Lampsilis anodontoides anodontoides</i>												
<i>L. a. fallaciosa</i>	2	(0.2)					1	(0.1)			1	(0.1)
<i>L. higginsii</i>	3	(0.3)					4	(0.4)				
<i>L. radiata siliquoides</i>	34	(3.1)	36	(21.8)	45	(5.3)	38	(3.6)	36	(9.2)	39	(2.4)
<i>L. ventricosa</i>	1	(0.1)					1	(0.1)			7	(0.4)
<i>Lasmigona complanata</i>	32	(2.9)	3	(1.8)	2	(0.2)	15	(1.4)	3	(0.8)	50	(3.1)
<i>Leptodea fragilis</i>	28	(2.6)	4	(2.4)	33	(3.9)	28	(2.7)	3	(0.8)	31	(1.9)
<i>L. laevissima</i>							1	(0.1)			4	(0.3)
<i>Lumina recta latissima</i>	31	(2.9)	2	(1.2)	25	(3.0)	62	(6.0)	4	(1.0)	27	(1.7)
<i>Obliquaria reflexa</i>	36	(3.3)	31	(18.8)	190	(22.5)	27	(2.6)	10	(2.6)	132	(8.3)
<i>Obovaria olivaria</i>	1	(0.1)			5	(0.6)	6	(0.6)	1	(0.3)	79	(4.9)
<i>Plagiola lineolata</i>											4	(0.3)
<i>Pleurobema cyphus</i>											1	(0.1)
<i>Pleurobema cordatum</i>	19	(1.7)	5	(3.0)			2	(0.2)			1	(0.1)
<i>Proterea alata</i>	1	(0.1)	1	(0.6)	2	(0.2)					2	(0.1)
<i>Tropidius undulatus</i>	24	(2.2)			18	(2.1)	21	(2.0)			13	(0.8)
<i>Truncilla donaciformis</i>	26	(2.4)			48	(5.7)	6	(0.6)	1	(0.3)	2	(0.1)
<i>T. truncata</i>												
<b>TOTAL MARGARITIFERA</b>	1000		165		845		1047		622		1599	
<b>TOTAL TAXA</b>	26		18		20		25		19		40	
<b>TOTAL SPECIES</b>	3		1		3		3		1		4	

# Table 1. (continued)

18		19		20		21		22		24	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
27	(2.4)	4	(1.0)								
<i>Amphileptidae</i>											
242	(21.2)	81	(20.6)	74	(53.2)	15	(14.4)	69	(21.6)	87	(41.6)
2	(0.2)					3	(2.9)				
64	(5.6)	26	(6.6)	12	(8.6)	4	(3.8)	10	(3.1)	10	(4.8)
80	(7.0)	4	(1.0)					3	(0.9)	21	(10.0)
27	(2.4)	1	(0.3)			1	(1.0)			1	(0.5)
13	(1.1)	2	(0.5)	3	(2.2)	2	(1.9)	25	(7.8)	15	(7.2)
180	(15.7)	43	(10.9)	20	(14.4)	7	(6.7)	24	(7.5)	10	(4.8)
90	(7.9)	10	(2.5)	8	(5.8)	11	(10.6)	27	(8.5)	17	(8.1)
<i>Anodontinae</i>											
49	(4.3)	1	(0.3)								
36	(3.1)	4	(1.0)	2	(1.4)	4	(3.8)	6	(1.9)	3	(1.4)
1	(0.1)	5	(1.3)			2	(1.9)	4	(1.3)		
12	(1.0)	1	(0.3)								
8	(0.7)										
<i>Anodontoides anodontoides</i>											
37	(3.2)	38	(9.6)	1	(0.7)	2	(1.9)	16	(5.0)	9	(4.3)
21	(1.8)	12	(3.0)	1	(0.7)	2	(1.9)	6	(1.9)		
22	(1.9)	56	(14.2)	2	(1.4)	2	(1.9)	37	(11.6)	8	(3.8)
5	(0.4)					1	(1.0)				
54	(4.7)	18	(4.6)	4	(2.9)	29	(27.9)	36	(11.3)	16	(7.7)
63	(5.5)	18	(4.6)	8	(5.8)	3	(2.9)	24	(7.5)	4	(1.9)
44	(3.8)	3	(0.8)			2	(1.9)	8	(2.5)	3	(1.4)
10	(0.9)	10	(2.5)	1	(0.7)	3	(2.9)	6	(1.9)	2	(1.0)
29	(2.5)	50	(12.7)	2	(1.4)	4	(3.8)	9	(2.8)	1	(0.5)
27	(2.4)	7	(1.8)	1	(0.7)	3	(2.9)	4	(1.3)	1	(0.5)
1143		304		199		104		319		209	
24	(0.7)	21		14		20		19		17	
3		1		3		3		4		1	

Fig. 1 indicates that there was present at an exploratory site in the pool.

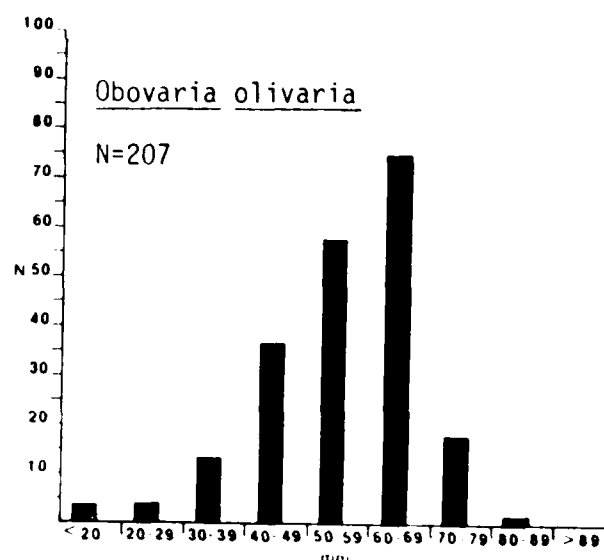
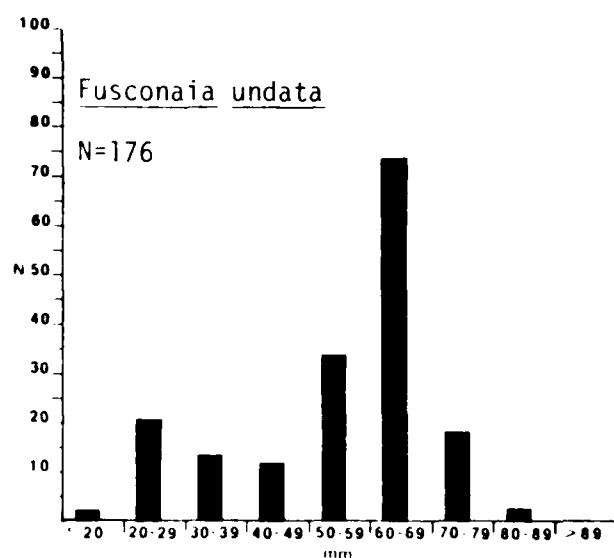
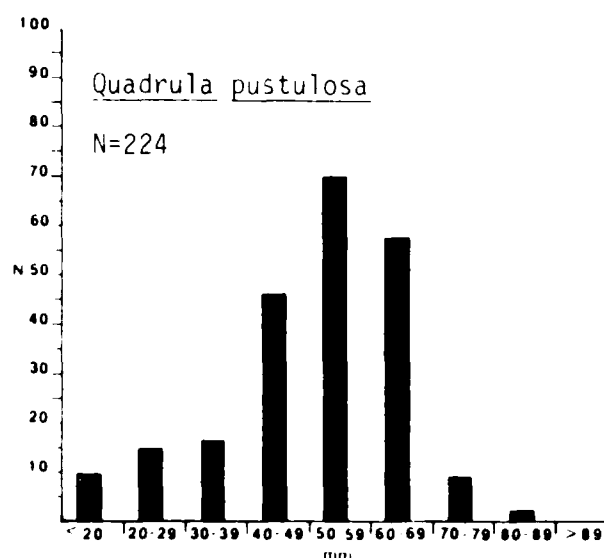
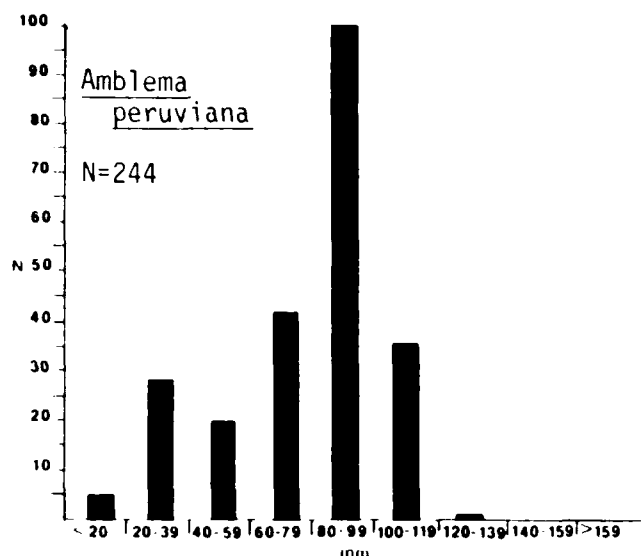


Figure 35. Length-frequency distribution of *Amblema peruviana*, *Quadrula pustulosa*, *Fusconaia undata* and *Obovaria olivaria* in the Rock Island District of the Upper Mississippi River, 1979-1980.

This species has increased in relative abundance since the 1930-1931 survey by Ellis when Q. pustulosa composed 4.98% of the mussels and was categorized as common throughout the Mississippi River (van der Schalie and van der Schalie 1950). Fuller (1978) also noted an increased proportion of Q. pustulosa in his survey of the Mississippi River. Years before the Ellis survey, the Pimple-back in the Mississippi River was described as very abundant (Marsh 1887-1889) and very common (Baker 1905).

Collection of numerous young individuals (<30 mm in length and 1-5 years old), the diverse and well-represented size classes (Figure 35), and the widespread distribution of this species indicated a viable reproducing population in the Upper Mississippi River. This is in agreement with Fuller's (1980) assignment of a Healthy classification for Q. pustulosa in the Mississippi River.

#### 4.2.3 Fusconaia undata (Pig-toe)

Fusconaia undata ranked third in abundance of the 35 taxa encountered in this survey and made up 8.75% of the Mississippi River mussel assemblage (Table 35). This species was recorded from 28 of 32 survey sites and was present in all pools of the Rock Island District (Table 36). The Pig-toe was especially abundant in the upstream pools and very common in the downstream pools. The 1975-1976 UMRCC survey (Perry 1979) and the 1977 Philadelphia Academy of Science survey (Fuller 1978) also reported F. undata was common throughout the river.

This species was collected from a variety of habitats, but tended to prefer areas with current. Fusconaia undata was never collected in the sandy main channel. Silt appeared to be the required substrate component limiting the distribution of adult F. undata. Adult individuals were found primarily in rocky and sandy habitats with large percentages of silt and were especially abundant in mussel beds. Numerous young adults, however, were recorded from predominantly sand substrates near the historic dredge disposal sites. A preference for sand bars by young and juvenile F. undata was also noted by Parmalee (1967).

The healthy status of F. undata was evident in this study by occurrence of several size classes (Figure 35), the presence of young specimens (<30 mm in length) in most pools, and the widespread distribution of large numbers of the species. Fuller (1980) also classified the present population of this species in the Mississippi River as Healthy.

#### 4.2.4 Obovaria olivaria (Hickory-nut)

Obovaria olivaria was recorded at 30 of the 32 survey sites in this study and was relatively abundant in all pools in the Rock Island District (Table 36). Parmalee (1967) described O. olivaria as a deep water species found on a sand or gravel bottom in good current. This was also the preferred habitat in the 1979 and 1980 survey. During the present survey, this species was seldom collected in shallow water and was never found in a predominantly silt substrate. Obovaria olivaria was the only species commonly collected in the shifting sand of the main channel. In addition, this species frequently occurred in mussel bed communities and was especially abundant in beds



located in the navigation channel. In the main channel mussel bed at the Lainsville Lower Site in Pool 13 (Table 7), *O. olivaria* had densities of 62 individuals/500-ft brail run and composed more than 80% of the fauna.

*Obovaria olivaria* has effectively adapted to the several dramatic physical and chemical changes that the Mississippi River has sustained during the last 100 years. This species has maintained abundant, stable populations throughout most of the river since the early studies in the late 1800s. Marsh (1887-1889) described *O. olivaria* as very abundant in the Mississippi River and ranked it second only to *Fusconaia ebena* in numbers. Surveys by Witter (1883), Keyes (1889) and Baker (1905) also categorized this species as very common in the river. More recent surveys by Ellis (1930-1931) (van der Schalie and van der Schalie 1950) and Fuller (1978) revealed that *O. olivaria* has continued to flourish in the Mississippi River, and relative abundance of this species has varied only slightly during the last 50 years. Overall percent occurrence of this species in the Ellis survey of 1930-1931 equalled 5.61% compared to 5.43% in Fuller's survey of 1977 and 6.45% in the present 1979-1980 survey (Table 35).

The common occurrence of *O. olivaria* in all pools of the Rock Island District and the well represented variety of size classes (Figure 35) supported the Healthy classification assigned by Fuller (1980). Young specimens of the Hickory-nut (<15 mm in length and 1-2 years old) were brailed by their byssal threads in Pools 13, 14, and 16. Juveniles probably were more abundant than the data indicated. Because of the deep water preference of this species, juveniles could be sampled only by brailing. This sampling technique appears to be inefficient, especially for collecting small juveniles (see discussions for Big Timbers and New Boston sites).

The common occurrence of *O. olivaria* in the main channel makes this species highly susceptible to channel dredging; however, large populations of *O. olivaria* were found in several areas outside of the main channel. It therefore seems probable that dredging will not have a drastic effect on the overall abundance of this species in the Mississippi River.

#### 4.2.5 *Megaloniaias gigantea* (Washboard)

*Megaloniaias gigantea* was abundant in mussel beds surveyed during this study but occurred at less than half of the channel-maintenance areas examined. The Washboard was observed primarily in the middle and upper pools of the Rock Island District during 1979-1980 (Table 36). This species was uncommon downstream of Lock and Dam 18, except in Pool 24 where 21 specimens were collected. The Washboard was typically collected from mussel beds or other densely populated main channel border habitats with mixed silt, sand and gravel substrates. The decreased abundance of *M. gigantea* in the lower pools reflected the lack of suitable stable silt and gravel substrates for mussel beds in the downstream pools. In this survey about 80% of the *Megaloniaias* were recorded from the mussel bed comparison sites (Tables 17, 18, and 19) and the beds in Andalusia Slough (Table 15). Samples collected by diving at these beds revealed Washboard densities ranging from 4.7 to 8.0 individuals/m<sup>2</sup>. The Washboard was usually found in deep water during this survey; however a dense population (maximum of 84 individuals/m<sup>2</sup>) was reported in only three feet of water at RM 485.5 in Sylvan Slough (Ecological Analysts, Inc. 1981a).

The relative abundance of *M. gigantea* increased from 1.17% in the 1930-1931 Ellis survey to 5.97% in the present study (Table 35). Early surveys by Witter (1883), Marsh (1887-1889) and Keyes (1889) described this species as rare in the Mississippi River; however, Baker (1905;1928) regarded the Washboard as common. *Megaloniaias* is reported to prefer a coarse gravel and mud substrate with a slow current (Parmalee 1967), thus the creation of the Mississippi River lock and dam system and the resulting pools with their increased sedimentation may have created a more favorable habitat for this species.

Although the Washboard was one of the predominant species observed during the 1979-1980 survey, size distribution data indicated that the population was dominated by larger, older individuals (Figure 36). The absence of juveniles and the few young adults suggested that recruitment in this population was minimal. In addition, *M. gigantea* is presently one of the most valuable shells for the cultured pearl industry and is heavily harvested by commercial clambers. However, the numerous Washboards collected in 1979-1980 suggests the survival of this species is more optimistic than the Troubled classification of Fuller (1980).

#### 4.2.6 *Quadrula quadrula* (Maple-leaf)

*Quadrula quadrula* composed 5.57% of the freshwater mussels during the 1979-1980 survey (Table 35). This species was recorded in all pools of the Rock Island District (Table 36) and at 27 of the 32 survey sites. The Maple-leaf was observed in a variety of habitats during this survey. Adults of *Q. quadrula* were very common in the mussel bed comparison sites but were sporadic in most other habitats. Soft bottomed sloughs and sandy main channels were the only areas in which the adults were not recorded. Juveniles and young adults were collected only in the sand and silty sand areas near the disposal sites in this investigation.

*Quadrula quadrula* has apparently increased in relative abundance during the last 100 years. Early surveys by Witter (1883) and Baker (1905) reported the species as uncommon in the river. However, by the time of the 1930-1931 survey of Ellis, the species had achieved common status and accounted for slightly more than 4% of the mussel fauna. A slight increase in relative abundance was noted between Ellis' data and data from the present survey in which *Q. quadrula* accounted for nearly 6% of the assemblage. The historic increase in relative abundance of this species was probably because of changes in habitat associated with the navigation system. The tolerance of this species to a variety of substrates (Parmalee 1967) and habitats present in impoundments (Bates 1962) suggested that the construction of dams in the Mississippi River favored populations of the Maple-leaf.

The varied distribution of size classes of the Maple-leaf (Figure 36) and widespread occurrence of juveniles and young adults indicated a healthy and reproducing population is present in the Mississippi River. Fuller (1980) reported this species to be uncommon in the upper pools of the river because of the adverse impact on the water quality by the Twin Cities; however, *Q. quadrula* was commonly collected in the middle pools of the Upper Mississippi River. Fuller classified *Q. quadrula* as Healthy in the Mississippi River and the present survey supports this assessment.

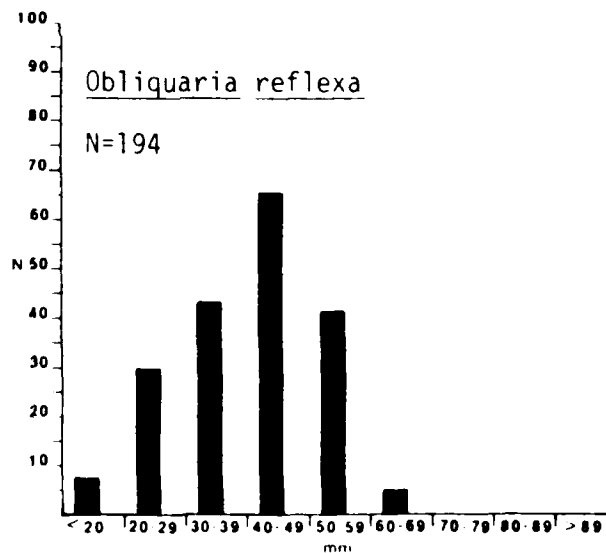
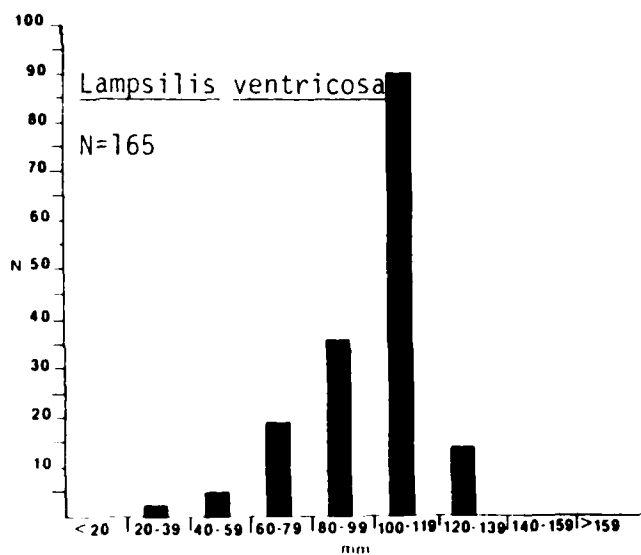
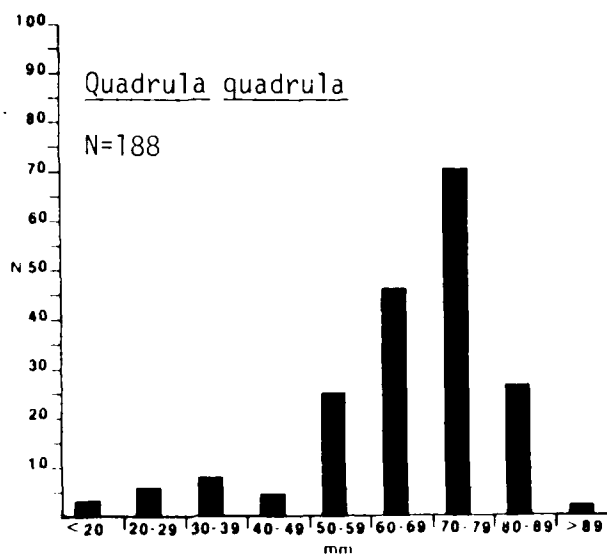
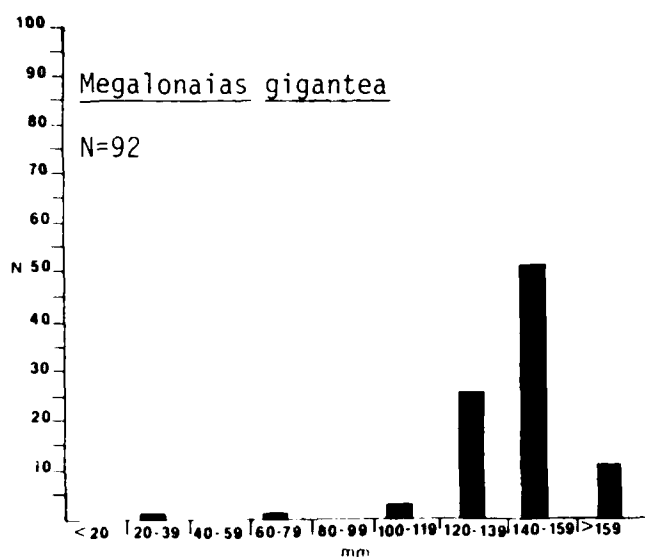


Figure 36. Length-frequency distribution of *Megalonaias gigantea*, *Quadrula quadrula*, *Lampsilis ventricosa* and *Obliquaria reflexa* in the Rock Island District of the Upper Mississippi River, 1979-1980.

#### 4.2.7 Lampsilis ventricosa (Pocketbook)

The Pocketbook composed 4.16% of the Mississippi River fauna in the Rock Island District in the 1979-1980 survey (Table 35). Lampsilis ventricosa was present at 27 of 32 survey sites and was present in Pools 11 through 24 (Table 36). This species, although widely distributed, was dominant only at the Maquoketa Levee Site in Pool 13 (Table 6). Lampsilis ventricosa was commonly observed in either mussel beds with predominantly gravel substrate or silty and sandy shallow areas near historic spoil disposals. In addition, the unstable sand bottom of the main channel frequently yielded individuals of the Pocketbook. A similar variety of habitats occupied by this species was noted by Parmalee (1967) and Coker (1919). Juveniles and young adults of L. ventricosa were most commonly observed in the upper pools (11 through 15) during this survey. Fuller (1978) also noticed greater numbers of juveniles in the northern half of the Upper Mississippi River.

Early studies by Marsh (1887-1889) described the Pocketbook as very common in the middle reach of the Upper Mississippi River which is now in Pools 17 and 18. In 1930-1931, L. ventricosa made up a portion of the Mississippi River fauna similar to the present study (Table 35). van der Schalie and van der Schalie (1950) reported that in 1930-1931 this species was distributed in the upper half of the river, primarily north of Guttenburg, Iowa. The present study and recent mussel data collected by Fuller (1978) and Freitag (1979) indicated this species was widespread in Pools 11 through 24, but was rarely the numerically dominant species.

The widespread and common occurrence of this species (Table 36) and its varied size class distribution (Figure 36) in the present survey indicate a Healthy classification for the Pocketbook. Fuller (1980) also described the present Mississippi River population of L. ventricosa as Healthy and attributed the species' present success to its numerous glochidial hosts. Dredging activity in the main channel may eliminate some individuals of L. ventricosa since the species frequently inhabits this area. However, the greatest densities of L. ventricosa were found out of the main channel and in this light, the numbers lost to dredging may be considered negligible.

#### 4.2.8 Obliquaria reflexa (Three-horned Warty-back)

Obliquaria reflexa was recorded from all pools (Table 36) and at 29 of the 32 sites evaluated in this investigation (Table 35). The Three-horned Warty-back was most abundant in the lower sandy pools of the Rock Island District and numerically dominated the fauna (27.9%) in the Pool 21 collections. Adults of the Three-horned Warty-back were observed in a variety of substrates and depths in channel border habitats with moving water. Young adults of O. reflexa (<30 mm in length and 1-4 years old) were commonly collected throughout the entire Mississippi River study area and were encountered frequently in sand and silty sand substrates near the disposal sites in areas with little or no current. Fuller (1978) occasionally collected young adults from the main channel sands of the Mississippi River. Only one individual was recorded from this habitat during this survey.

Obliquaria reflexa has had a widespread distribution and common relative abundance in the river since the late 1800s. This species was regarded as common in the Mississippi River by Witter (1883) and Baker (1905), and

abundant by Keyes (1889). Coker (1919) considered this species widespread but not abundant. In the present survey, *O. reflexa* was considered common and widespread. Relative abundance of *O. reflexa* during 1979-1980 (3.30%) was similar to Fuller's (1978) survey and Ellis' 1930-1931 study (Table 35).

This species' present status was classified as Healthy by Fuller (1980). The varied size class distribution (Figure 36), occurrence of numerous young adults, and widespread distribution of the species in the present survey also indicated a healthy, reproducing population of *O. reflexa* in the Mississippi River. The possible absence of a parasitic stage for *O. reflexa* (Fuller 1978) and tolerance to a variety of substrates probably account for the present success of this species.

#### 4.2.9 *Truncilla donaciformis* (Fawn's Foot)

The Fawn's Foot was observed in all pools except Pool 15, during 1979-1980 but was usually not abundant (Table 36). *Truncilla donaciformis* composed 2.74% of the mussels collected in this survey and occurred at 25 of the 32 sites examined (Table 35). Shorelines of the historic and future disposal sites yielded numerous juvenile and adult *T. donaciformis*. Adults were most frequently encountered in fine gravel or silty sand substrates and juveniles were recorded from sandy or sandy gravel habitats.

Quantitative frame samples collected in the mussel bed comparison sites revealed that the Fawn's Foot was one of the predominant bed species (Tables 17 and 19). Abundance of adults of this species probably has been frequently underestimated because of their small size and difficulties associated with brailing this species. Juveniles of *T. donaciformis*, however, were commonly brailed by their byssal threads in this survey and by Fuller (1978). Fuller (1978) recorded numerous juveniles by brailing in the Mississippi River main channel at potential dredge cut areas. He attributed their occurrence in this unstable habitat to their byssal threads which entwine drifting vegetable detritus. According to Fuller (1980), this procedure allowed juveniles to move along the bottom without being buried by the moving bedload.

*Truncilla donaciformis* was reported as a common mussel in the Mississippi River in the earliest recorded surveys conducted in the late 1800s (Witter 1883; Marsh 1887-1889; Keyes 1889). Ellis' 1930-1931 survey and the present study also determined that *T. donaciformis* was a common and widely distributed species in the Mississippi. The figures in these two studies were similar (Table 35). Fuller (1978) reported a much larger percentage of *T. donaciformis* in the Mississippi River; however, this was attributed to collection of numerous juveniles in pools upstream from the Rock Island District.

This survey supported the Healthy classification of this species by Fuller (1980). The widespread distribution of *T. donaciformis*, the numerous juveniles recorded (Figure 37), and the large densities recorded at the mussel bed sites indicated an abundant, reproducing population of this species in the Upper Mississippi River. Although juveniles of the Fawn's Foot have been recorded commonly from the main channel, dredge cuts in these areas probably would eliminate a negligible number of this species. Dredging

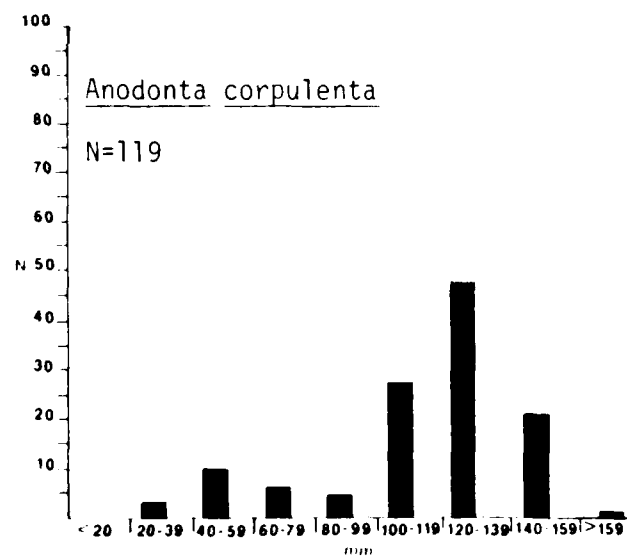
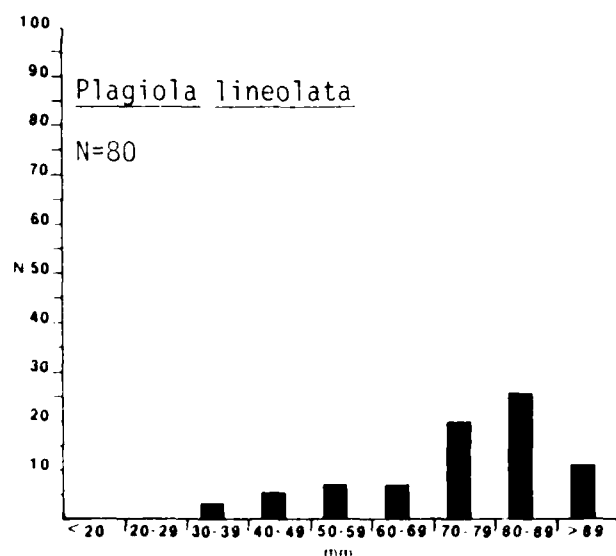
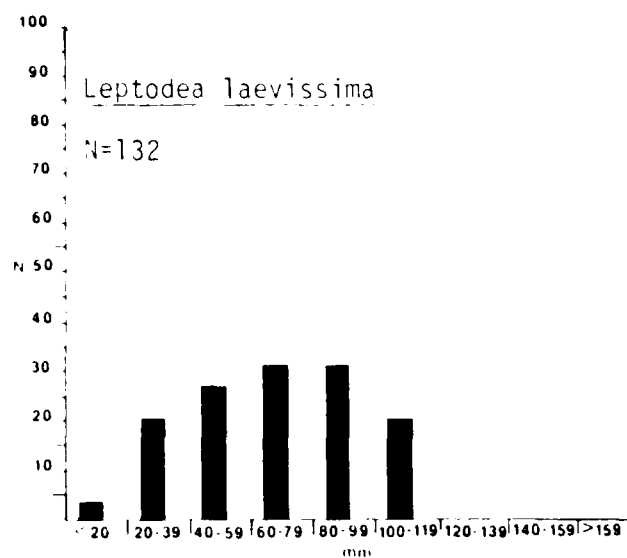
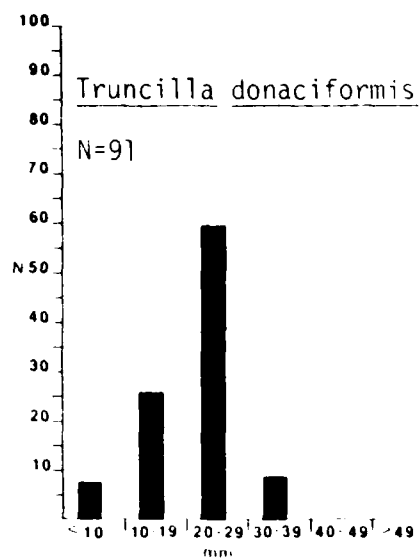


Figure 37. Length-frequency distribution of Truncilla donaciformis, Leptodea laevisissima, Plagiola lineolata and Anodonta corpulenta in the Rock Island District of the Upper Mississippi River, 1979-1980.

is conducted in a small percent of the total Mississippi River channel and therefore only a small portion of the juveniles of this species would be disturbed by dredging activity. In addition, adults of T. donaciformis were most abundant in channel border areas which would not be affected by dredge cut activity.

#### 4.2.10 Leptodea laevisissima (Pink Paper-shell)

Leptodea laevisissima constituted 2.67% of the Mississippi River mussel assemblage during this survey (Table 35). This species was widely distributed in the Rock Island District occurring in all pools (Table 36) and at 29 of 32 survey sites. Despite its wide distribution, the Pink Paper-shell usually occurred in small numbers and made up a large component of the mussel fauna only at sites in the lower pools (Pools 18 through 24). Leptodea laevisissima adults were generally collected from silt and sand substrates during this survey and were especially abundant near disposal sites with a silty sand bottom. Juveniles of this species were found primarily in silty areas. Young adults were frequently recorded in shallow nearshore areas with a silt-free substrate.

Leptodea laevisissima juveniles were commonly brailed by their byssal threads during this study. Fuller (1978) described this species as characteristic of navigation channel sands in addition to its typical preference for backwater areas. He attributed the success of L. laevisissima in the moving sand bedload to its mobility and the unusually long extension of its siphonal apertures. The extended siphons, which aid survival in the shifting sand of the channel, also allow L. laevisissima to bury itself deeply in silty substrate in quiet water areas it inhabits (Parmalee 1967).

Some early investigations in the Iowa portion of the Mississippi River found L. laevisissima to be common (Witter 1883; Keyes 1889), while Marsh (1887-1889) described this species as uncommon and Baker (1905) did not report the Pink Paper-shell. The relative abundance of the Pink Paper-shell in the present study was similar to the 1930-1931 survey (Table 35). van der Schalie and van der Schalie (1950) reported this species as common throughout the Upper Mississippi River during 1930-1931 Ellis survey but noted it was more frequently collected in the lower stretch. Parmalee (1967) stated that the Pink Paper-shell was a southern species in Illinois and was common in the Mississippi River only as far north as the Rock River. Fuller (1978) also reported his greatest collections of L. laevisissima in the lower pools (especially Pool 19).

Fuller (1980) regarded the present population of L. laevisissima in the Mississippi River as Healthy. The numerous juveniles and young specimens (<40 mm in length and 1-3 years old), varied size class distribution (Figure 37), and widespread distribution in the present study supports this classification.

Because of the possible occurrence of L. laevisissima in the navigation channel, this species could be affected by main channel dredging activity. Populations of L. laevisissima, however, occur most frequently in shallow channel border and backwater areas which are typically not influenced by dredge cuts.

#### 4.2.11 Plagiola lineolata (Butterfly)

The Butterfly ranked 11th in abundance (2.27% of the total fauna) and was collected at 16 of the 32 survey sites in 1979-1980 (Table 35). This species was recorded in 11 of 13 pools investigated. Plagiola lineolata was recorded primarily from areas with large mussel densities and was usually not common at the proposed dredge sites surveyed in 1979-1980. More than 85% of the individuals collected were from mussel beds in Pools 16-18 (Table 36). These beds were characterized by mixed silt, sand and gravel substrates and relatively dense mussel concentrations. Young adults were occasionally recorded from shallow sandy channel border habitats. Baker (1928) described the Butterfly as a large river species which occurred in the Mississippi River on sand, gravel and mud substrates. As noted by Coker (1919) and Fuller (1978), comparatively fewer females than males were observed in the present Mississippi River collections. Recent surveys in the Mississippi River indicated that P. lineolata was relatively common at sites with high mussel densities (Freitag 1978; Fuller 1979; NUS Corp. 1979; Ecological Analysts, Inc. 1981a). Data from these surveys and the present study indicate the Butterfly is a common mussel bed species in the middle pools of the Mississippi River and, although not abundant, it is more common than the rareness indicated by Fuller (1980).

Relative abundance of P. lineolata increased between 1930-1931 when it comprised 0.41% of the Mississippi River fauna and the present survey in which the species accounted for 2.27% of the total assemblage (Table 35). The 1977 survey by Fuller (1978) recorded this species' relative abundance (0.48%) similar to 1930-1931. The large percent occurrence of P. lineolata in the 1979-1980 survey may be related to its success in the Rock Island District when compared with other portions of the river. Marsh (1887-1889) and Baker (1905) regarded the Butterfly as uncommon to rare in the Mississippi River. Witter (1883), Shimek (1888) and Keyes (1889) classified it as common. Plagiola was considered common throughout the river in 1930-1931 but was most frequently collected in the upper reach (van der Schalie and van der Schalie 1950).

The present survey indicated that P. lineolata was relatively common in the river and the population contained various size classes (Figure 37). Fuller (1980), however, classified P. lineolata as Troubled because of its relatively uncommon abundance and, its preference for mussel bed habitats, and its sensitivity to poor water quality. The usual occurrence of the Butterfly in densely populated mussel beds exposes this species to the adverse impacts of commercial mussel harvesting for the cultured pearl industry and subjects the species to injuries caused by recurrent brailing and, more seriously, to habitat destruction due to commercial dredging for mussels. Parmalee (1967) reported the Butterfly is less tolerant of siltation and pollution than many species and it has completely disappeared from the Illinois River where these adverse conditions exist. However, data from several recent surveys (including the present study) indicate the survival of P. lineolata in the Mississippi River was tentatively classified as Healthy.



#### 4.2.12 Anodonta corpulenta (Stout Floater)

Anodonta corpulenta composed 1.85% of the Mississippi River mussel assemblage during the 1979-1980 survey (Table 35). The Stout Floater was present at 27 of the 32 survey sites, and in all pools, but never composed a dominant proportion of the fauna (Table 36). Anodonta corpulenta was collected at a variety of habitats during this survey but was primarily observed in sloughs or other still-water areas with substrates containing a large percentage of silt. The Beaver Island dredge site yielded the largest numbers of this species during 1979-1980 (Table 8). Sampling on the slough side of a disposal site yielded 49 specimens of the Stout Floater, accounting for nearly 30% of the fauna at this site. The construction of the lock and dam system on the Mississippi River and the resulting pools with increased backwater areas probably has been favorable for this lentic taxon.

Before 1900, individuals of the Anodonta grandis complex, which includes A. corpulenta, were described as common in the Mississippi River (Witter 1883; Marsh 1887-1889). This species was also in the Mississippi River in Ellis' 1930-1931 survey when it made up 3.12% of his total collection (Table 35). A slight decrease in relative abundance occurred between 1930-1931 and the present study. This decline probably was not an actual population decrease but reflected the intensified sampling effort near the main channel dredge sites and not in the backwater areas where A. corpulenta is most common. The 1977 dredge site survey by Fuller (1978), which also stressed main channel areas, yielded similarly low proportions of this species.

Taxonomic problems in the A. grandis complex make it difficult to assess the health of the A. corpulenta population. Fuller (1980) did not recognize the species A. corpulenta and considered all individuals of this complex in the Mississippi River as the species A. grandis. He classified this population as Healthy. Regardless of the systematic questions, this taxon was widely distributed in the Mississippi River in the present study and the numerous young adults (<80 mm in length, 1-5 years) and varied size classes (Figure 37) attest to its Healthy status in the river.

#### 4.2.13 Quadrula nodulata (Warty-back)

The Warty-back ranked as the 13th most abundant species during this investigation (Table 35). This species composed 1.71% of the total mussel fauna and was present at 22 of the 32 sites investigated. Quadrula nodulata was collected in all pools of the Rock Island District but was abundant only in the middle (Pools 14 and 15) and lower (Pools 22 and 24) sections of the District (Table 36). The abundance of Q. nodulata in the lower pools may reflect its preference for the predominantly sand substrate in this portion of the Mississippi River. The Warty-back occurred in a variety of habitats including deep water mussel beds, shallow areas near dredge disposal sites and occasionally the main channel. Each of these habitats sustained some current. Adults were present in mussel beds and other channel border areas with relatively dense communities but were generally sparse in number. Baker (1928) and Parmalee (1967) reported adult Q. nodulata usually occurred in a mud bottom; however, most adults in this study were collected from a sandy gravel or sand substrate. The greatest densities of this species and especially of young adults were found in stable sand and silty sand substrates

near the site disposal areas. Baker (1928) found juvenile shells abundant on sand bars.

The relative abundance of Q. nodulata in the present survey was similar to the 1930-1931 survey (Table 35). Mississippi River data from 1930-1931 (van der Schalie and van der Schalie 1950), 1977 (Fuller 1978) and the present survey indicated the Warty-back was infrequent in the upper pools of the Mississippi River and common in the middle and lower pools. Baker (1928) described Q. nodulata as a species of southern distribution. This species was considered rare in the river prior to 1900 (Witter 1883; Marsh 1887-1889; Keyes 1889). Tolerance of the species to a variety of habitats, including impoundments, and excellent reproductive success (Fuller 1978) are the probable reasons for the current success of the Warty-back.

Fuller (1980) regarded this species as healthy in the Mississippi River. Its widespread distribution, the presence of a variety of size classes (Figure 38) and numerous young specimens (<40 mm in length and 1-6 years old) in the present study supported this assessment. In addition, Q. nodulata apparently has increased in number since its pre-1900 classification as rare.

Although Q. nodulata occurs sporadically in and near the main channel, channel maintenance dredging probably will not adversely affect this population in the Mississippi River. The greatest densities of this species occurred in areas out of the channel which would not be influenced by dredging.

#### 4.2.14 Leptodea fragilis (Fragile Paper-shell)

Leptodea fragilis composed 1.70% of the Mississippi River mussel assemblage during 1979-1980 and occurred at 20 of 32 survey sites (Table 35). This species was present in all pools of the Rock Island District except Pool 24 but never constituted more than 4% of the fauna in any pool (Table 36). This species was observed in most habitats in the Mississippi River except backwater areas with silt-clay substrates. Leptodea fragilis appeared to prefer a sandy habitat with current. The Fragile Paper-shell was relatively common in the silty and sandy gravel substrates of mussel beds and was frequently found in the sand and silty sand areas near disposal sites. In addition, this species occasionally occurred in shifting sands of the main channel. Juveniles of this species were collected by their byssal threads in brailing and raking throughout the river.

The Fragile Paper-shell exhibited a dramatic decline in relative abundance since 1930-1931 when it was the second most commonly encountered species and made up 10.10% of the assemblage (Table 35). Fuller (1978) also noted a decreased percentage (1.27%) of L. fragilis in 1977. Early surveys of the Mississippi River reported L. fragilis as common to abundant (Witter 1883; Marsh 1887-1889; Baker 1905).

The widespread distribution of L. fragilis in this survey, the numerous juveniles and young specimens (<40 mm in length and 1-3 years old), and the well represented size classes (Figure 38) support the Healthy classification proposed by Fuller (1980). The decreased occurrence of this species from 1930-1931 to the present cannot be adequately explained.

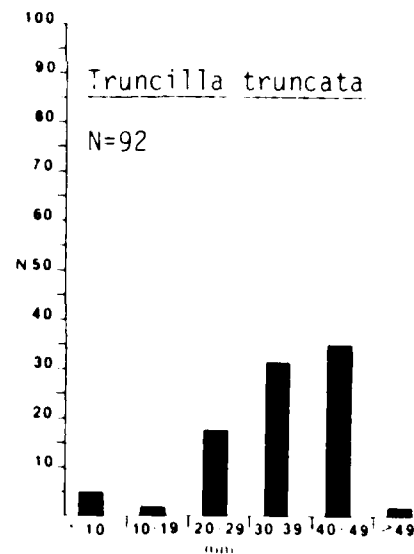
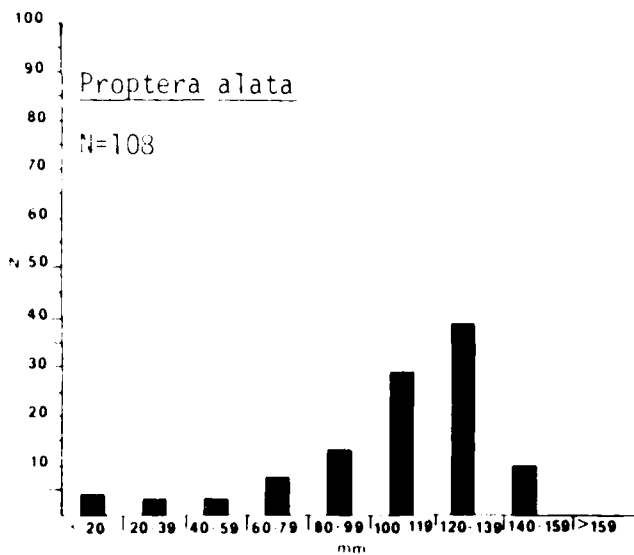
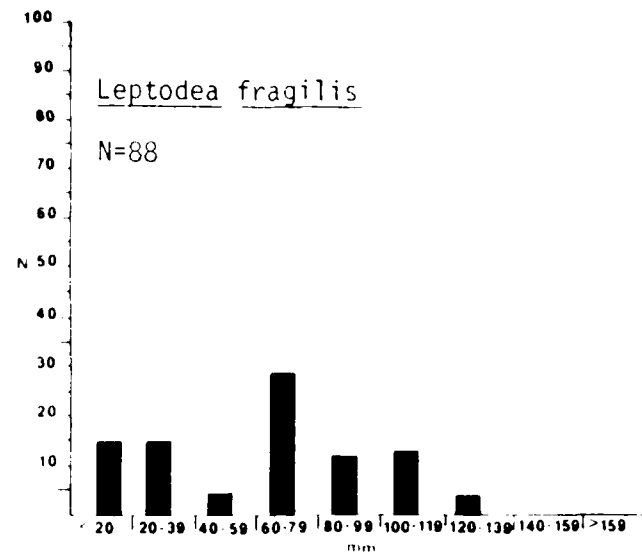
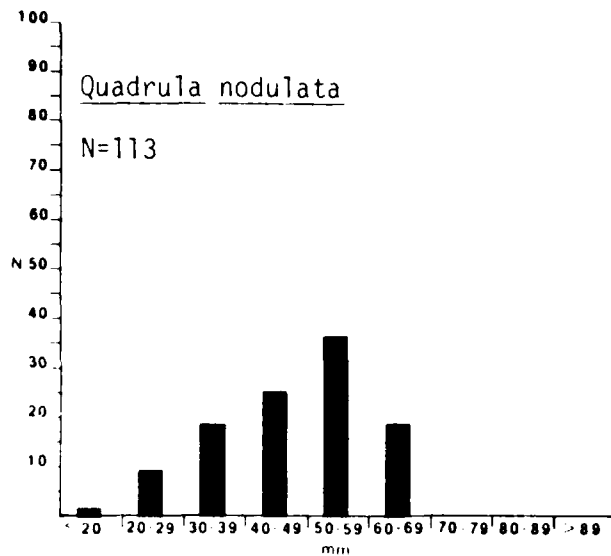


Figure 3. Length-frequency distribution of *Quadrula nodulata*, *Leptodea fragilis*, *Proptera alata* and *Truncilla truncata* in the Rock Island District of the Upper Mississippi River, 1979-1980.

The occurrence of L. fragilis in the main channel makes this species susceptible to channel dredging; however, in this survey, most individuals were collected out of the main channel. Therefore, channel dredging is not expected to drastically affect the overall abundance of the Fragile Paper-shell in the Mississippi River.

#### 4.2.15 Proptera alata (Pink Heel-splitter)

Proptera alata was present at 23 of the 32 survey sites during 1979-1980. A total of 149 individuals were collected and composed 1.53% of the total mussels collection (Table 35). The Pink Heel-splitter was never a dominant species but was observed in all pools except Pool 13 (Table 36). During this survey, juveniles and adults of P. alata were collected primarily in substrates with high percentages of silt. This species was observed in habitats ranging from deep, gravelly channel-border areas with steady current to shallow backwater areas in still water. In each habitat, however, silt constituted a large proportion of the substrate. The Pink Heel-splitter was not collected from the sandy bed of the main channel. Juveniles of this species were collected by brailling and raking in Pools 15 and 16. These juveniles were brailed by their byssal threads.

Proptera alata has declined in abundance during the last century. Early studies by Witter (1883) and Baker (1905) described this species as common in the Mississippi River. Marsh (1887-1889) collected P. alata in rare numbers in the river proper but described the species as common in sloughs along the river. Proptera alata was also common in the survey conducted by Ellis in 1930-1931 (van der Schalie and van der Schalie 1950). During Ellis' survey, the species was widely distributed throughout the river and constituted nearly 4% of his collection (Table 35). The relative abundance of the Pink Heel-splitter declined, however, between Ellis' 1930-1931 survey and the present survey.

Fuller (1980) categorized the status of this species as Troubled in the Mississippi River primarily because of its apparent decline since the 1930-1931 survey by Ellis. The present survey also revealed a somewhat smaller relative abundance of P. alata; however, included in the collection were several juveniles and young adults (<60 mm in length and 1-4 years old), and a variety of size classes (Figure 38). In addition, the species exhibited a wide geographical distribution within the river. These factors all indicated a somewhat healthier population than suggested by Fuller (1980).

#### 4.2.16 Truncilla truncata (Deer-toe)

Truncilla truncata made up 1.53% of the Mississippi River assemblage collected in 1979-1980 (Table 35). The Deer-toe was collected in all pools of the Rock Island District during this investigation except Pool 12 and occurred at 21 survey sites. The species was common only in Pool 13 (5.7% of the fauna; Table 36). Sampling in mussel beds and other areas with large mussel densities yielded numerous specimens of T. truncata during the present study. This species exhibited preference for the silty and sandy gravel habitats sustaining a steady current, typical of most mussel beds. Similar to Truncilla donaciformis, diving revealed that densities of T. truncata in the mussel beds were much greater than were indicated by brailling. Quadrat

samples handpicked by a diver revealed the Deer-toe to be the third most abundant species at the Big Timbers and New Boston mussel beds, but the species was uncommon in concurrent brail runs (Tables 17 and 19, respectively).

The Deer-toe was frequently sampled by hand collections in shallow sand and silty sand areas near the dredge disposal sites. Juveniles of this species (<10 mm in length and 1-2 years old) were collected in mussel beds and near dredge disposal areas in Pools 11, 18 and 19. These small specimens were collected when their byssal threads became entangled in the brail and mussel rake.

Truncilla truncata appears to have increased in abundance since the late 1800s. Witter (1883) and Marsh (1887-1889) reported this species was rare in most areas of the river. Baker (1905), however, described T. truncata as common in the northern Iowa water of the Mississippi River. In Ellis' 1930-1931 survey, the species was regarded as common, particularly in the upper portions of the river (van der Schalie and van der Schalie 1950). Fuller (1978) recorded a continual increase in the abundance of the Deer-toe in his extensive survey of 1977. The present study also revealed somewhat larger numbers of T. truncata than recorded by Ellis in 1930-1931.

The increased relative abundance of T. truncata since 1930-1931, its widespread distribution, the varied size class distribution (Figure 38) and the presence of juveniles indicated a balanced, reproducing population currently in the Mississippi River. These findings agreed with Fuller's (1980) classification of Healthy. The success of this species has likely been due to the abundance of its glochidial hosts, the sauger and freshwater drum, and its occurrence in a variety of channel border habitats in addition to mussel beds.

#### 4.2.17 Actinonaias carinata (Mucket)

The Mucket composed 1.14% of the Mississippi river fauna during 1979-1980 and was collected at nine of the 32 survey sites (Table 35). Distribution of Actinonaias carinata was restricted to the middle section of the Rock Island District (Pools 15-19) and was especially common (4.3% of the fauna) in Pool 18 (Table 36). In a 1977 survey of the Mississippi River, the Mucket was commonly collected only in Pool 19 (Fuller 1978).

During the present study, A. carinata was collected primarily in silty and sandy gravel substrates of mussel beds. More than 80% of A. carinata found in 1979-1980 occurred in mussel beds in Pools 16, 17 and 18. Brail data indicated the Mucket was one of the most common species in these beds. Baker (1928) reported this species preferred a shallow sand and gravel habitat with a swift current. The present distribution of A. carinata in the middle section of the Rock Island District may be a reflection of its historic occurrence in this preferred habitat prior to construction of the lock and dam system. This portion of the river still provides the most compatible habitat for this species. The only young A. carinata (68-74 mm in length and 5-6 years old) were observed in Pools 18 and 19. Two young individuals occurred in diver-collected samples in the New Boston mussel bed (Table 19). One individual was collected in Pool 19 by pollywogging near a historic disposal site with a silt and clay substrate (Table 22).

*Actinonaias carinata* has declined in the Mississippi River during the last 100 years. In early surveys Witter (1883) and Marsh (1887-1889) considered this species common in the Mississippi River. Baker (1905) noted the Mucket was one of the most common shells he encountered. By 1930-1931, however, the survey by Ellis yielded only a small number of *A. carinata* and noted that the species occurred primarily in the northern half of the Upper Mississippi River (van der Schalie and van der Schalie 1950).

Fuller (1980) considered the population of *A. carinata* in the Mississippi River as Jeopardized and indicated that the species faces extirpation. He attributed its decline to commercial over-harvesting and possibly to poor water quality. The present survey in the Rock Island District revealed the Mucket was more widely distributed and perhaps not as rare in the Mississippi River as indicated by Fuller (1978) and indicated this species' status is only Troubled. However, the few young individuals collected in the present study (Figure 39), the on-going effects of the commercial mussel industry and the adverse habitat alteration by the lock and dam system disclose a pessimistic future for this species in the Mississippi River.

#### 4.2.18 *Quadrula metanevra* (Monkey-face)

*Quadrula metanevra* ranked 18th in abundance during the 1979-1980 survey (Table 35). Although the Monkey-face was collected in 10 of 13 pools in the Rock Island District, it was only common (>2) in Pools 17 and 18, and was observed in only 13 of 32 survey sites (Table 36). Fuller (1973) also found the largest concentration of *Q. metanevra* in Pool 18 in his survey of the Mississippi River.

*Quadrula metanevra* was collected primarily at the mussel bed comparison sites in Pools 17 and 18 during this survey. Nearly 80% of the specimens collected in this study were recorded from these two sites. This species was frequently encountered in other areas with large mussel densities. Apparently the Monkey-face prefers the stable silty, sand and gravel substrate and steady current common in mussel beds. Coker (1919) reported *Q. metanevra* was infrequent in large mussel beds, and usually occurred near the shore or outside the main beds. As noted by Parmalee (1967) and in this study, adults of *Q. metanevra* were usually found in deep water and a substrate with a small percent of silt and clay. The few young specimens collected in the present survey (27-59 mm in length and 5-9 years old) were recorded from the sandy main channel in Pool 11 (Table 2) and a shallow sandy area near a dredge disposal site in Pool 14 (Table 10).

Historical trends in the abundance of *Q. metanevra* are uncertain although it has apparently had a restricted distribution within the river. Data from the late 1800s suggest that the species has been restricted to the region of the river encompassed by present day Pools 16 through 18. Surveys by Witter (1883) and Marsh (1887-1889) revealed the Monkey-face was common to very abundant in areas that are now Pools 16 through 18. Baker (1905), however, collected only one valve of this species in a 1904 survey in the area of Pool 10. The species was common in Ellis' 1930-1931 survey, and he also reported its greatest numbers in the area that is now Pool 18 (van der Schalie and van der Schalie 1950). As noted above, the survey by Fuller (1973) and the

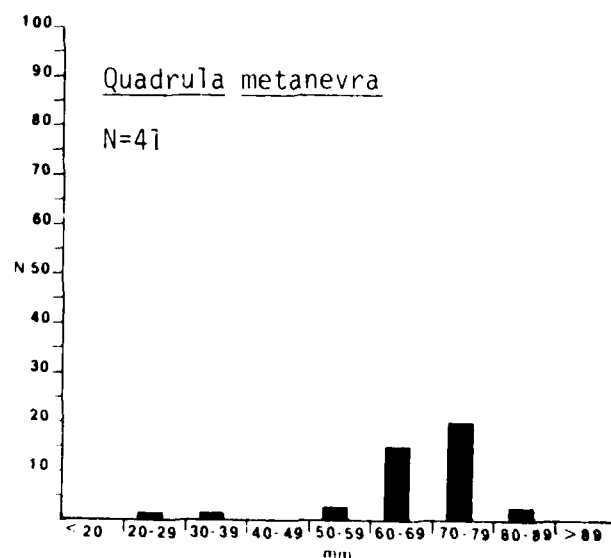
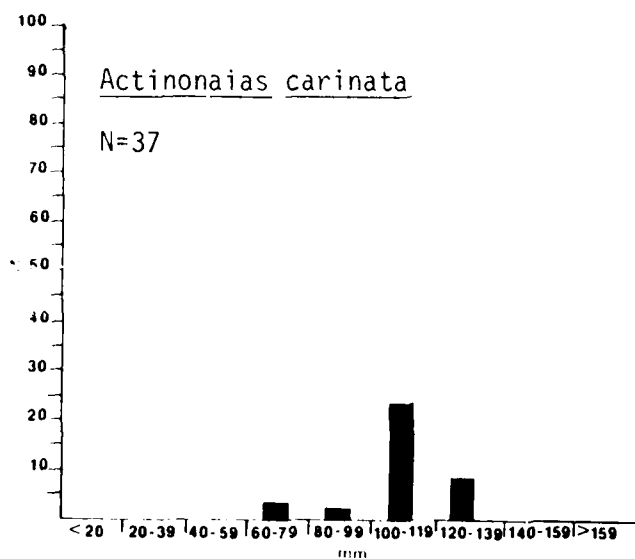


Figure 39. Length-frequency distribution of Actinonaias carinata and Quadrula metanevra in the Rock Island District of the Upper Mississippi River, 1979-1980.

present study both determined Q. metanevra was rare in the upper Mississippi except in Pools 17 and 18. Densities in Pools 17 and 18 reported by Fuller (1978) and in this 1979-1980 survey were smaller than reported in 1930-1931 by Ellis.

Fuller (1980) categorized Q. metanevra as a Troubled species in the Mississippi River. The decline of this species since 1930-1931 and its present rarity in the Upper Mississippi River (Fuller 1978) were probable reasons for this classification. The present small relative abundance of this species in the Mississippi River probably can be attributed to the loss of habitat resulting from construction of the lock and dam system and the adverse affects of the commercial mussel industry on the mussel bed communities. The present survey supports Fuller's Troubled classification of Q. metanevra. The 1979-1980 survey recorded a lower proportion of this species than in 1930-1931. In addition, only a few young specimens of Q. metanevra were collected in 1979-1980 (Figure 39).

#### 4.2.19 Corbicula fluminea (Asiatic Clam)

Corbicula fluminea occurred at 11 of 32 survey sites constituting 0.83% of the collection during this investigation (Table 35). The Asiatic Clam was present in Pools 11 through 19 during 1979-1980 and was most common in Pools 16 and 18 (Table 36). During the present study, Corbicula was collected primarily in shallow channel border areas in stable silty sand or sand substrates. This small species was usually collected by raking and occasionally by pollywogging, but never by brailing. The natural northern range limit of Corbicula is not known; however, recent surveys indicated that thermal discharges were supporting populations of this exotic species in the upper reaches of the Mississippi River (Eckblad 1975; Lewis 1977, 1979; Cummings and Jones 1978). Corbicula was not recorded at any dredge survey site north of Pool 13 in 1979-1980. Three dredge sites in Pool 11 and one site in Pool 12 were surveyed and yielded no individuals of Corbicula; however, further investigations at exploratory sites in these pools revealed Asiatic Clam populations present immediately downstream from power plants in Cassville, Wisconsin (Pool 11) and Dubuque, Iowa (Pool 12). These data suggest that populations of Corbicula in Pools 11 and 12 are being sustained by heated discharge water from these power plants. Corbicula collected in Pool 13 and further downstream were not associated with heated discharges.

The absence of this species in Pools 20 through 24 could not be explained but may have been related to the predominantly unstable shifting sand substrate in these pools or the adverse water quality impacts of the Des Moines River which joins the Mississippi River in Pool 20.

Corbicula could create potential problems for the freshwater mussel fauna if its densities become excessive. The Asiatic Clam has been reported to be competitive with and supplant freshwater mussels from sandy substrates (Fuller and Richardson 1977). This competition for space is not likely to occur in the Mississippi River since the greatest mussel densities occur in silty sandy gravel substrates which are not favorable for Corbicula.

This introduced species was first recorded in the Upper Mississippi River in 1969 at Lock 27 (Thomerson and Myer 1970). Since 1969, Corbicula has spread throughout the Upper Mississippi River basin and has been reported in Pool 19



(Pogge and Schneider 1980), Pool 14 (Lewis 1977), Pool 9 (Eckblad 1975), the lower St. Croix River (Fuller 1978) and the lower Minnesota River (Cummings and Jones 1978).

#### 4.2.20 Arcidens confragosus (Rock Pocketbook)

Arcidens confragosus ranked 20th in abundance during 1979-80 and composed 0.54% of the mussel fauna (Table 35). The Rock Pocketbook was collected at only 10 of the 32 survey sites including seven pools in the middle and upper sections of the Rock Island District (Table 36). The greatest abundance of this species was recorded in Pools 17 and 18. Young and old adults of A. confragosus were most commonly collected from mussel beds and other areas of the Mississippi River with large mussel densities. Three juveniles of this species (15-28 mm in length and 2-3 years old) were recorded from a backwater area near the Lock and Dam 15 Lower Approach Site (Table 12). The present study indicated that a mixed silty and sandy gravel substrate with a constant current was the preferred habitat for adult A. confragosus; however, other researchers have reported this species from mud substrates in quiet waters (Marsh 1887-1889; Parmalee 1967). During this survey only juveniles of this species were recorded in muddy backwater habitats.

Information from past surveys indicates this species has been uncommon in the Mississippi River during the past 100 years. Prior to 1900, A. confragosus was regarded as rare in the Mississippi River (Witter 1883; Marsh 1887-1889); however, Baker (1905) considered this species as common. Coker (1919) described A. confragosus as rare but widely distributed. This species exhibited a wide geographical range but occurred in small numbers in Ellis' 1930-1931 Mississippi River survey (van der Schalie and van der Schalie 1950). The present survey and the 1977 survey by Fuller (1978) recorded a slight increased abundance of A. confragosus from 1930-1931 when it composed only 0.10% of the mussel assemblage (Table 35).

The small numbers of A. confragosus collected during 1979-1980 and the on-going damage to this population by the commercial mussel industry support the Troubled classification assigned to this species by Fuller (1980). This species, however, has never been abundant in the Mississippi River. The current population, although small, is slightly greater in relative abundance than was recorded in 1930 and 1931. In addition, the large percentage of juvenile and young adults in the present study are evidence of reproduction in this population. This species survival in the Mississippi River may be more favorable than the Troubled status suggested by Fuller.

#### 4.2.21 Ligumia recta latissima (Black Sandshell)

Ligumia recta latissima ranked 21st in abundance in the 1979-1980 survey and made up only 0.33% of the mussel assemblage (Table 35). The Black Sandshell was present at 11 of the 32 survey sites and occurred primarily in the middle section (Pools 13 through 21) of the Rock Island District (Table 36). This species was most commonly collected in Pool 15 (8 individuals) and in Pool 17 (12 individuals). In this survey, L. r. latissima was collected only in mussel beds or other similar habitats with large mussel densities. This species was found primarily in a silty and sandy gravel substrate in deep water with a constant current. Marsh (1887-1889) also reported that the

Black Sandshell inhabited the deep water in the Mississippi River and noted that it was seldom found near the margin. The only juvenile of *L. r. latissima* collected in this survey was brailed by its byssal thread at a main channel mussel bed near Bogus Island in Pool 17 (Table 18).

*Ligumia recta latissima* was reported as common in the Mississippi River from the earliest recorded surveys of the late 1800s through 1930-1931 when Ellis conducted his intensive survey. Witter (1883), Baker (1905) and Coker (1919) all reported *L. r. latissima* as a common species widely distributed in the Mississippi River. Between 1930 and the modern day study by Fuller (1978), this species has declined in abundance. In the present study, relative abundance of *L. r. latissima* was less than one-half the proportion reported by Ellis in 1930-1931.

Fuller (1980) reported that the Black Sandshell has been injured by the mussel industry and further limited by deteriorating water quality of the Mississippi River. He classified this species' prospects for survival in the Mississippi River as Troubled. The decreased occurrence of *L. r. latissima* in the present survey and the collection of only one young individual support the Troubled classification of Fuller.

#### 4.2.22 *Carunculina parva* (Lilliput Shell)

*Carunculina parva* made up only 0.29% of the mussels collected in 1979-1980 and occurred at only 8 of the 32 survey sites (Table 35). This species was present in five of the pools in the Rock Island District and was most abundant in Pool 11 (Table 36). Adults of *C. parva* were collected primarily in shallow still-water habitats with a mixed silt and clay substrate during this survey. Parmalee (1967) usually found this species occurring in a habitat similar to the present study. In 1979-1980 adults were occasionally recorded near the dredge spoil disposal sites with various soft substrates in areas with little current. Juveniles of the Lilliput Shell were collected only in Pool 11 near disposal sites with soft substrates sustaining river flow. Juveniles were collected by their byssal threads in rake and brail samples. Approximately 95% of the *C. parva* reported by Fuller (1978) in the Upper Mississippi River were juveniles and were collected primarily in the upper pools (Pools 4 through 10). Fuller brailed many of these juveniles in the main channel.

The abundance of *C. parva* in modern surveys appears to have increased since early studies of the river. Witter (1883) reported the species was uncommon in the Mississippi River. van der Schalie and van der Schalie (1950) interpreted the small numbers of *C. parva* collected by Ellis in 1930-1931 as an indication that this species was not a common member of river fauna. Fuller (1978) reported that this species was common (2.36%) in his collections of 1977. Fuller (1980) noted that *C. parva* had probably been overlooked in most surveys due to its small adult size and usual occurrence in backwater habitats that have been infrequently sampled.

The present survey and the 1977 investigation by Fuller (1978) suggest C. parva is a common mussel of the Upper Mississippi River. In addition, the apparent increase in distribution and abundance of C. parva since 1930-1931 and the common occurrence of its juveniles support the Healthy classification (Fuller 1980) of this population.

#### 4.2.23 Anodonta imbecillis (Paper Pond Shell)

A total of 27 Anodonta imbecillis were collected in the 1979-1980 survey and accounted for 0.28% of the total mussel collection (Table 35). The Paper Pond Shell was widely distributed in the Rock Island District, occurring at 13 of 32 survey sites and 9 of the 13 pools investigated. The species was, however, not abundant in any of the sites or pools (Table 36).

Parmalee (1967) reported this species inhabits pools and shallow bank areas of large rivers living on fine grain sand or, more often, in silt and clay mud substrates. In the present study, A. imbecillis was found in habitats similar to those reported by Parmalee (1967). Adults of the Paper Pond Shell were primarily collected from silty substrates in shallow channel border areas near spoil disposal sites. Adults were also found in still water slough habitats. Because these areas were sampled infrequently in the present study, the abundance of this species may be underestimated. Juveniles of A. imbecillis were collected only in channel border habitats near disposal sites.

Anodonta imbecillis constituted a smaller fraction of mussel fauna in this study than was reported in Ellis' 1930-1931 survey when it composed 2.62% of the fauna (Table 35). Fuller (1978) in his 1977 survey noted that A. imbecillis was widespread, reporting a percent occurrence (2.11%) similar to Ellis survey. The Paper Pond Shell was described in 1930-1931 as common throughout the Upper Mississippi River (van der Schalie and van der Schalie 1950). Before 1900, this species was regarded as very abundant in the sloughs of the river (Marsh 1887-1889).

Marsh (1887-1889) noted the occurrence of numerous juvenile A. imbecillis in his collections but reported an absence of full grown individuals. He could not explain an apparent die-off in which approximately half of the population died when not over one-fourth grown. An absence of full grown adults was also observed in the present survey. This species is able to bear more than one brood per season (Fuller 1980) and develops without a glochidial host (Coker 1919). These two factors may account, in part, for the large proportion of young and juvenile A. imbecillis reported by Marsh (1887-1889) and those observed in the present survey.

Based on the widespread distribution of A. imbecillis in modern surveys and occurrence of the species in numbers similar to data from 50 years ago, Fuller (1980) classified this population as Healthy. The numerous young individuals of A. imbecillis and wide distribution in the present survey support the Healthy classification.

#### 4.2.23 Lasmigona complanata (White Heel-splitter)

Thirteen Lasmigona complanata were collected in 1979-1980, accounting for only 0.13% of the mussel assemblage (Table 35). Although the White Heel-splitter was infrequently collected (only 7 of the 32 sites and 5 of the 13 pools surveyed), this species had a broad range in the Rock Island District (Table 36). This species occurred in Pools 11, 14, 16, 17, and 22. Lasmigona complanata was most abundant at survey sites in Pools 16 and 17.

The White Heel-splitter is reported to occur in both small and large streams primarily in soft substrates in shallow still water habitats (Baker 1928; Parmalee 1967). Marsh (1887-1889) collected this species in the sloughs of the river and reported it to be very mobile. In the present survey, adults of this species were collected in mussel beds with predominantly gravel substrates and in silty sand channel border areas. The adults were collected in both deep and shallow water habitats, and in a variety of current velocities. Only young individuals of L. complanata were observed in backwater habitats during this survey. Two individuals (43 and 63 mm in length, approximately 3-4 years old) were collected from the Arsenal Island pond in Pool 16. Fuller (1978) recorded juveniles of this species in muddy shallows of Pool 16 and backwater shallows of Pool 19.

Several early surveys of the Mississippi River reported L. complanata as either common or abundant (Witter 1883; Marsh 1887-1889; Keyes 1889; Baker 1905). In 1930-1931, this species was regarded as widespread in distribution and common in abundance (van der Schalie and van der Schalie 1950). Recent surveys suggest this species has decreased in abundance from its historical occurrence. Fuller (1978) reported widespread distribution but small relative abundance of this species in his 1977 survey and Perry (1979) considered L. complanata to be rare in the Upper Mississippi River. Intensive sampling in backwater areas may reveal larger populations of this species than reported herein and in other recent investigations.

Fuller (1980) considered populations of this species in the Mississippi River as Troubled based on a present day decrease in abundance of L. complanata in comparison to early surveys. Declining water quality and commercial over-harvesting have been suggested as causes for the decline of this species (Fuller 1980). The presence of juveniles and the widespread distribution of this species are indicative of an optimistic Troubled classification; however, further sampling in backwaters is needed to clarify the status of this population.

#### 4.2.24 Lampsilis anodontoides anodontoides (Yellow Sandshell)

The Yellow Sandshell was collected only in lower Pools 21 through 24 in this survey of the Rock Island District (Table 36). Overall, this taxon was a minor component of the total Mississippi River mussel fauna (0.09%; Table 35).

Baker (1928) described Lampsilis anodontoides anodontoides as a large river species found in a variety of habitats ranging from sandy substrates in swift current to mud bottoms in quiet waters. In the present survey, the Yellow Sandshell was collected primarily from silty sand substrates in depths

ranging from a few inches to five feet. This taxon occasionally occurred in areas with steady currents but was most frequently collected in still waters. Coker (1919) reported the Yellow Sandshell to be more active than any other Mississippi River species and was frequently observed to move up onto shoals with rising water. In the present study, L. a. anodontoides exhibited a preference for shallow sand flats created by dredge spoil disposal. The species occurred at 5 of the 30 dredge sites examined, and at 3 of the sites this species inhabited sand flats created by dredge spoil disposal.

Lampsilis a. anodontoides has decreased in abundance since the earliest recorded surveys of the river. Early researchers did not separate this species into the two forms discussed in this report (L. a. anodontoides and L. a. fallaciosa). Witter (1883) and Marsh (1887-1889) both reported L. anodontoides to be abundant in the river. In 1904, Baker (1905) also regarded the Yellow Sandshell to be common in the Mississippi River. In 1930-1931, L. a. anodontoides composed 2.06% of Ellis' collection (Table 35) and was considered common throughout the river (van der Schalie and van der Schalie 1950). Recent surveys by Fuller (1978), Perry (1979) and the present 1979-1980 survey demonstrated a decline in the abundance of this subspecies and a distribution restricted to the lower pools of the Rock Island District. Fuller (1978) and Perry (1979) both reported this taxon only from Pool 19. As noted above, in the present survey L. a. anodontoides was collected only in Pools 21 through 24.

In summary, data from the present survey and from other recent investigations showed a decline in the abundance of this species and determined that the species is restricted to the lower pools of the Rock Island District. The decline of L. a. anodontoides in the Mississippi River and its present occurrence only in the lower pools of the Rock Island District cannot be explained. Fuller (1980) regarded populations of L. anodontoides, which included both L. a. anodontoides and L. a. fallaciosa, as Jeopardized in the Mississippi River and data from this 1979-1980 survey support this classification.

#### 4.2.25 Plethobasus cyphus (Bullhead)

Plethobasus cyphus was rare in the 1979-1980 survey and collected at only 3 of 32 areas surveyed in 1979-1980. A total of nine individuals were collected and made up only 0.09% of the total mussels (Table 35). Populations of the Bullhead were observed only in Pools 16 and 17 in this survey (Table 36).

Parmalee (1967) described P. cyphus as a large river species found in mud bottoms in areas with current. In the present study, the Bullhead was observed in mussel beds or other areas of large mussel concentrations. The species occurred in areas with current, in mixed silt, sand and gravel substrates. The Bullhead was collected in deep waters of 8-15 ft depth. Marsh (1887-1889) also found this species in deep water of the Mississippi River. Other recent collections of P. cyphus have been from mussel beds in Pool 15 (NUS Corp. 1979; Ecological Analysts, Inc. 1981a); Pool 17 and 18 (Perry 1979) and Pool 20 (Fuller 1978).

Early surveys of the river seem to indicate that the species has experienced a decline in abundance and decrease in range since the late 1800s. The Bullhead was common in the area that is now Pools 16, 17 and 18 in the late 1800s (Witter 1883; Marsh 1887-1889). Ellis' 1930-1931 survey reported P. cyphus was widely distributed in the river; however, the number of individuals collected was very small (van der Schalie and van der Schalie 1950). Overall, the relative abundance of the species in Ellis' survey was similar to the present 1979-1980 investigation. Recent surveys by Fuller (1978) and Perry (1979) also indicated that the species is rare in the Rock Island District of the Mississippi River. Fuller (1978) surveyed Pools 1 through 21 in 1977 and failed to collect a single individual. Perry (1979) reported P. cyphus as rare in his 1975-1976 survey, occurring only in Pools 17 and 18.

The apparent decreased abundance of this species since early surveys and its present rare occurrence in the river support the Jeopardized classification of P. cyphus by Fuller (1980). The Bullhead probably has suffered from the commercial harvesting of mussel beds, which is the preferred habitat for this species.

#### 4.2.26 Strophitus undulatus (Strange Floater)

Strophitus undulatus was rare in the 1979-1980 survey. The species was collected at only 5 of the 32 sites examined (Table 35). A total of six S. undulatus were collected in this study. Only single individuals were collected, and these occurred at scattered locations in four of the upper pools of the Rock Island District. Recent studies by Fuller (1978) and Perry (1979) also reported the species as uncommon in the Mississippi River.

This species' preferred habitat is generally in strong currents on sandy or gravelly bottoms in small creeks or large rivers (Marsh 1887-1889). In the present survey, S. undulatus was collected only by brailing in mussel beds or other deep-water channel border areas with sand or gravel substrates and a strong current.

The abundance of S. undulatus in the Mississippi River apparently has decreased during the last 100 years. Marsh (1887-1889) indicated this species was rather abundant; however, Witter (1883) described the Strange Floater as rather rare in the river. Baker (1905) reported S. undulatus as a common species in the river. In Ellis' 1930-1931 survey, S. undulatus accounted for nearly 1% of the collection (versus 0.06% in this study) and was widely distributed in the upper pools of the river (Table 35).

Although S. undulatus has declined in abundance since early studies of the Mississippi River, Fuller (1980) categorized this species as Troubled rather than Jeopardized. This somewhat optimistic classification, in spite of its present rare occurrence, was attributed to the collection of S. undulatus in a heavily polluted zone of the Upper Mississippi River. In addition, Fuller recognized that S. undulatus is one of the few mussels whose glochidia may develop without dependence on an intermediate fish host (Coker 1919). The ability of glochidia to develop independent of an intermediate host may afford S. undulatus greater reproductive success than other species that require glochidial parasitism on a definitive fish species.

Despite S. undulatus' apparent ability to tolerate extremely polluted environs and the possibility of facultative glochidia, the Troubled classification of Fuller (1980) may be overly optimistic as the infrequent collection of S. undulatus in the present survey and the absence of young individuals suggests a Jeopardized classification of this species may be appropriate.

#### 4.2.27 Fusconaia ebenus (Ebony Shell)

Fusconaia ebenus was rare in the 1979-1980 survey, occurring at only two of the 32 sites surveyed (Table 35). A total of five individuals were collected from mussel beds in Pools 18 and 21 (Table 36). The individuals observed in the 1979-1980 survey were all old adults (>15 years old). This species was most abundant at the Pool 21 site, in a mussel bed with historic commercial value. In the present survey, the Ebony Shell occurrence was restricted to deep-water mussel bed habitats characterized by a silty and sandy gravel substrate, and steady current. In early studies, F. ebenus was reported to be a deep water species, preferring gravelly bottoms and avoiding muddy substrates (Marsh 1887-1889). The species was commonly collected in swift currents by Baker (1928).

The Ebony Shell was commonly collected in early surveys of the Mississippi River (Witter 1883; Shimek 1888). Marsh (1887-1889) described F. ebenus as the most abundant species in the river, equalling in numbers all other mussel species combined. Coker (1919) reported that F. ebenus constituted 80% of the mussels in some beds in the Mississippi River. At that time, it was the most sought after shell for the pearl button industry. A population decline from these early studies was evident in the 1930-1931 survey by Ellis when this species comprised only 3.56% of the total fauna (Table 35). Recent investigations also indicate F. ebenus is now rare in the Mississippi River. Fusconaia ebenus was rare in the 1975-1976 Mississippi River survey by Perry (1979) and was absent in the 1977 investigation by Fuller (1978).

This species began to decline in the Upper Mississippi River when spawning runs of its primary glochidial host, the Skipjack Herring (Alosa chrysochloris), were impeded by lock and dam construction in the river (Fuller 1978). The reduction of this species' glochidial host and the commercial harvesting for the pearl button industry resulted in the near elimination of this population in the Mississippi River. The rare occurrence of F. ebenus and the absence of juveniles in the present survey confirmed the Jeopardized status of this species assigned by Fuller (1980).

#### 4.2.28 Lampsilis radiata siliquoidea (Fat Mucket)

The Fat Mucket was rarely collected in this 1979-1980 mussel survey (Table 35). Lampsilis radiata siliquoidea occurred only at two sites in Pool 11 and in both areas constituted a small component of the mussel assemblage (Table 36). In this survey, adults of the Fat Mucket were collected from a substrate of predominantly silt and clay mixed with lesser amounts of sand. The only young individual recorded (48 mm in length and approximately 4 years old) occupied a sandy substrate. All individuals were hand collected along historic spoil disposal at shallow depths near shore. Marsh (1887-1889) found L. r. siliquoidea in the sloughs of the river. Coker (1919) reported

the Fat Mucket was rarely found in rapidly moving water, but usually in slow or still water. He noted that when the species was found in rivers, it usually occurred close to shore.

Lampsilis radiata siliquoidea has apparently declined in abundance since the late 1800s and early 1900s. The Fat Mucket was one of the most valued shells of the pearl button industry (Coker 1919). The species was reported as common in the area encompassed by Pools 16 through 18 by Marsh (1887-1889). In addition, in early studies by Baker (1905) the species was common in the area that is now Pool 10. As recently as the 1930-1931 survey by Ellis, the species was relatively common in northern sections of the river (van der Schalie and van der Schalie 1950). The species was most abundant in a commercial bed in Lake Pepin (Pool 4) and was not collected south of what is now Pool 10. Overall, the Fat Mucket constituted nearly 5% of Ellis' total collection (Table 35). Recent studies, however, have indicated L. r. siliquoidea is rare in the Mississippi River. Perry (1979) reported five individuals of this subspecies only from Pool 9 in the 1975-1976 UMRCC. In an extensive 1977 survey of the Mississippi River by Fuller (1978) only six individuals were collected, and none were collected farther south than Pool 10. The L. r. siliquoidea collected in Pool 11 during the present survey was probably at the southern limits of its present range in the Upper Mississippi River.

Fuller (1980) classified the potential for survival of L. r. siliquoidea in the river as Troubled. The present survey supported this classification in light of the sparse number of individuals collected; however, it should be pointed out that the present survey was conducted only along the fringe of this taxon's range. In addition, this taxon, while rare in the river, remains abundant in many small streams of the Mississippi River basin (Mathiak 1979; Parmalee 1967).

#### 4.2.29 Anodonta suborbiculata (Flat Floater)

Only one individual of Anodonta suborbiculata was collected in the 1979-1980 survey of the Rock Island District (Table 35). This mussel was taken from a pond on Arsenal Island in Pool 16 (Table 12). This pond, although usually connected to the main stem of the river, was protected from any current and, therefore, always presented a quiet water habitat. The substrate in the pond was primarily a silt-clay mixture with scattered rubble. Parmalee (1967) reported the preferred habitat of this species to be quiet, mud bottom sloughs and river pools. Havlik (1979) observed this species in backwater areas at a depth of five feet. This type of backwater habitat was infrequently sampled in both the present study and in most other recent surveys. Additional surveys in this type of habitat may reveal that large numbers of A. suborbiculata still exist in the ponds and sloughs of the Mississippi River.

Anodonta suborbiculata has been rare in the river since the late 1800s. The only two records of this species occurring in large numbers were provided by the early studies of Marsh (1887-1889) and Witter (1883). Marsh (1887-1889) reported that A. suborbiculata was common in the river during the 1870s but noted it declined to rare densities by the late 1880s. Witter (1883) found A. suborbiculata in abundant numbers in Keokuk Lake of the



Mississippi River. Subsequent studies, through modern times, consistently have found the species to be rare or absent in the river. Ellis' extensive survey of 1930-1931 did not report a single individual of *A. suborbiculata* (Table 35). Similarly, Fuller (1978) in his 1977 survey failed to collect any representatives. However, these surveys did not intensively sample backwater areas which are the preferred habitats for the Flat Floater. The only modern documented record of *A. suborbiculata* in this reach of the river (in addition to the present survey) was provided by Perry (1979), who observed the species in Pool 20.

Although Fuller (1978) failed to collect a single *A. suborbiculata* in his 1977 survey, he classified populations of *A. suborbiculata* in the river only as Troubled and not as Jeopardized. This classification probably was assigned because there was reason to suspect the occurrence of substantial numbers of this species in backwater habitats that have received only cursory attention in recent mussel investigations. Only a few backwater areas were examined in the present survey and, therefore, no assessment was made of the present status.

#### 4.2.30 *Elliptio dilatatus* (Spike)

*Elliptio dilatatus* was a minor component of the mussel assemblage in the Rock Island District (Table 35). In this survey the Spike was only observed from one site in Pool 11 (Table 36). This individual was brailed from a channel border habitat with relatively large mussel densities (52 individuals/ 500-ft brail run). The species was collected in a silty sand substrate at a depth of approximately 10 feet. Baker (1928) described *E. dilatatus* as primarily a large river species occurring in a wide range of habitats. Fuller (1978) reported that the Spike favors established mussel beds in the Mississippi River.

Although *E. dilatatus* has occurred sporadically in the middle pools of the Rock Island District (USFWS 1980), the present southern limits of this species' distribution in the Mississippi appears to be in the area of Pool 11. The spike, however, does occur further south in other drainages (Parmalee 1967). Historically, large populations of this species extended further south in the river. Several early authors (Witter 1883; Shimek 1888; Keyes 1889) reported *E. dilatatus* to be common in an extensive area in the Iowa reach of the river. The southern range of this species' distribution apparently receded to its present limits by the time of Ellis's 1930-1931 survey. He reported the species was common (1.98% of the fauna) but was present only in Pool 10 and areas further north (van der Schalie and van der Schalie 1950). Similar findings were reported by Fuller (1978). Fuller reported this species occurred only north of Pool 11 and noted that *E. dilatatus* can be locally common in the upper reach of the river. The Wisconsin DNR (1979) collected the Spike in association with large numbers of other mussels at numerous locations in Pools 9 through 11.

Fuller (1980) classified potential survival of this species in the Mississippi River as Troubled. He indicated *E. dilatatus* was rarer than it was in 1930-1931, but remained common at some locations and exhibited some evidence of recruitment (Fuller 1978). As was noted for *Lampsilis radiata siliquoidea*, the present survey included only a small portion of the present

range of E. dilatatus in the Mississippi River and the number of individuals collected was insufficient to assess the status of this species.

#### 4.2.31 Lampsilis anodontoides fallaciosa (Slough Sandshell)

Only one individual of Lampsilis anodontoides fallaciosa was collected in the 1979-1980 survey of the Mississippi River (Table 35). The lone individual of L. a. fallaciosa was collected from a historic island disposal site in Pool 14 (Table 10). In recent surveys of the river, L. a. fallaciosa has been reported live only in Pools 19 and 10 (USFWS 1980). The Slough Sandshell was observed in a substrate of clay and silt at a depth of 3-6 inches. Little current was present at this location. Baker (1928) reported that fallaciosa is an inhabitant of muddy sloughs or pond-like cut-offs of the river, where there is little current. Witter (1883) found the small, green-rayed form of L. anodontoides (by definition = fallaciosa) to prefer muddy sloughs. Future surveys in backwater habitats of the Mississippi (which were infrequently sampled in the present study) may yield larger populations of L. a. fallaciosa.

The Slough Sandshell was the dominant species in the 1930-1931 collections by Ellis (Table 35) and was considered common throughout the Upper Mississippi River (van der Schalie and van der Schalie 1950). Baker (1905) regarded L. a. fallaciosa as uncommon in the river. As discussed earlier, the forms of Lampsilis anodontoides were not treated separately prior to 1900; however, the species was described as common to abundant in the Mississippi River (Witter 1883; Marsh 1887-1889).

Fuller (1978) did not differentiate between the forms of this species; however, he classified the survival of L. anodontoides as Jeopardized. The dramatic decline of this taxon from 1930-1931, which has been noted in all recent surveys of the river, suggest this is a proper classification for the population of L. a. fallaciosa.

#### 4.2.32 Pleurobema cordatum (Ohio Pigtoe)

Pleurobema cordatum was a minor component of the 1979-1980 Mississippi River mussel assemblage (Table 35). This species was only collected from Pool 16 in a commercially valuable mussel bed (Table 15). The bed was situated in a side channel habitat with a silty sand substrate, a steady current and a depth of approximately 10 feet. Fuller (1978) collected this species in habitats similar to the present survey. Although the P. cordatum reported by Fuller were associated with abundant mussel faunas, the assemblages were not comparable to commercially valuable beds. The Ohio Pigtoe was also observed in relatively deep water of the Mississippi River by Marsh (1887-1889).

Pleurobema cordatum, according to early literature, has been rare in the Mississippi River since the late 1800s. Witter (1883), Marsh (1887-1889), Baker (1905) and Coker (1919) all described the species as rare to very rare in the river. In 1930-1931, Ellis' extensive survey yielded only ten individuals of P. cordatum (van der Schalie and van der Schalie 1950). These individuals were all collected in the area of the river that is now Pool 4, and it was suggested that P. cordatum was not an indigenous member of the

Mississippi River mussel fauna. The Ohio Pigtoe has also been sparse in modern surveys. In the wide-ranging survey by Fuller (1978), only two individuals were collected. These were collected from Pools 4 and 10. Pleurobema cordatum was not recovered in the 1975-1976 UMRCC survey (Perry 1979) and only rarely occurred in the Wisconsin DNR (1979) survey of Pools 9 through 11. Additional records for this species include collections in Pool 17 in 1976 (van der Schalie and Bates 1976) and in 1980 (Stanley Consultants, Inc. 1980).

Data from the present study indicates a Jeopardized status for this rare species. Fuller (1980) also classified this species as Jeopardized in the Mississippi River based primarily on its sporadic occurrence in only very small numbers. It should be noted, however, that owing to its close resemblance to the common species Fusconaia undata, P. cordatum may have been underestimated in modern studies. This species, while certainly rare, may be slightly more abundant than recently reported due to the possible confusion of P. cordatum with F. undata.

## 5.0 EFFECTS OF CHANNEL MAINTENANCE ACTIVITIES ON UPPER MISSISSIPPI RIVER MUSSELS

### 5.1 CHANNEL MAINTENANCE ACTIVITY IN THE UPPER MISSISSIPPI RIVER

To maintain the present 9-ft channel in the Rock Island District of the Upper Mississippi River, regular inspections are conducted by the USACOE in the river channel to insure the 9-ft depth. A detailed site survey is then performed at any problem area to determine the specific dredging requirements. The buildup of sand bedload, or relatively large grain material in close contact with the river bed, is the primary reason for channel dredging. The transport of fine grain substrates, or suspended load, is not a problem in the main channel but may create sedimentation problems in boat harbors.

Dredging of the Mississippi River main channel in the Rock Island District is accomplished by two general types of equipment. The primary dredge used in the Rock Island District is a pipeline cutterhead dredge which can continuously excavate the substrate with a revolving cutter, pump the material through a suction pipe and discharge the slurry through a trailing pipe at the surface. The trailing pipe can be directed to place the slurry either at a nearby open water site or a distant terrestrial site. This type of dredge results in a large amount of run-off during disposal. The biological impact of the slurry disposal would depend upon the type of sediment that is dredged. In addition to the benthic organisms directly impacted by dredging, the possibility of entraining drifting organisms outside of the dredge cut also exists.

The second type of dredging equipment utilizes either a dipper or a clamshell bucket to physically remove a portion of the substrate and bring it to the surface. The dredge spoil can then be placed in a barge and transported to a disposal. These types of dredges are not as efficient as the pipeline cutterhead dredge, but the amount of sedimentation and run-off during dredging and spoil disposal is significantly reduced. In addition, the area of the dredge cut can be kept to a minimum.

The mussel assemblage of the Mississippi River has been altered by numerous environmental influences in addition to the maintenance procedures of the navigation channel. Other changes that have occurred in the river include the decline in water quality, the increase in sediment and chemical run-off from agriculture, the growth of the commercial mussel industry, the loss of glochidial fish hosts, and the development of the sand and gravel industry. Similar alterations have been noted in other large rivers of the Midwest such as the Illinois, Minnesota, and Ohio rivers. The individual or synergistic effects of these influences may have had greater impact on the Mississippi River mussel fauna than past channel maintenance.

### 5.2 HISTORIC CHANNEL MAINTENANCE EFFECTS

The impact of the early navigation alterations upon the freshwater mussel assemblages of the river was not documented; however, the resulting restricted flow and increased sedimentation in the channel border and side

channel habitats probably devastated many mussels and their habitats. The completion of the present lock and dam system and the creation of the pools probably caused greater changes in the Mississippi River mussel assemblage than all of the other navigation improvements. Lotic species formerly inhabiting silt-free substrates in shallow rapids of the river began to decline. Species formerly living in the diverse backwater habitats also decreased in number. Some species, however, flourished in the newly formed pools.

In addition to the increased depth created by the impoundments, dredging was required to maintain the 9-ft channel. Site-specific effects of the initial 9-ft channel dredging activity on the freshwater mussel fauna was not documented. However, in the present study, numerous sub-fossil shells were collected at several dredge disposal sites in areas of the river with low mussel densities indicating past localized destruction of mussel faunas. Havlik and Stansbery (1977) documented the occurrence of freshly killed mussels in dredge spoils resulting from channel dredging in the St. Paul District of the river. Fourteen specimens of the Endangered Lampsilis higginsii and approximately 1,600 specimens of other species were collected at one disposal site. Dredging a mussel bed not only destroys many individuals but also destroys the stable habitat required by many species.

### 5.3 FUTURE DREDGING EFFECTS

The impact of recent channel dredging at the sites surveyed in the present study of the Rock Island District appeared to be minimal. The dredge spoils observed in this survey were composed primarily of sand, indicating a stable habitat had not been destroyed. Most dredge spoils contained few recently killed mussels. One exception in the 1979-1980 survey was the Centennial Bridge Site, which had a spoil composed primarily of rubble and contained several recently killed mussel specimens.

The USACOE (1978) collected sediment and water samples at several main channel dredge sites in the Rock Island District prior to and during dredging activity. Several of these 1978 sites were also investigated in the present survey. The dredged substrate was determined to be predominantly medium to fine sand containing only minor amounts of pollutants listed by the U.S. Environmental Protection Agency (USEPA 1976). During dredging activity, upstream-downstream differences in water quality were insignificant. These data suggest that the content of the dredged substrate at these sites would have little effect on biota during channel dredging and disposal. A similar low content of pollutants would be expected in the predominantly medium to fine sand substrate of the channel dredge sites observed in the present study.

The main channel mussel fauna outside of the dredge cut is predicted to be only slightly influenced by future dredging. In the present survey of the Rock Island District, a paucity of mussels was observed in the shifting sand bedload of the main channel. No Endangered or other special status species were collected in the area of future dredge cuts. The few dense mussel assemblages that were observed in or near the main channel were in deep habitats which would not require dredging. The most abundant mussels in the

sparse assemblages of the main channel were (in decreasing order of abundance), *Obovaria olivaria*, *Lampsilis ventricosa*, *Quadrula pustulosa*, *Leptodea fragilis* and *Leptodea laevis*. The total number of each species in the main channel was only a small portion of the total individuals collected in the present survey. In a 1977 survey of the Mississippi River (Fuller 1978), numerous juveniles of *Carunculina parva* and *Truncilla donaciformis* were collected in the main channel. Fuller (1980) indicated that these juveniles are common inhabitants of the unstable environment of the main channel. In the present survey, however, these species were most frequently collected from habitats outside of the channel.

In the present study, fine-grain substrates, such as silt and clay, were not observed in the main channel areas scheduled for dredging but were present at future harbor maintenance sites. These fine-grain particles are easily suspended in the water column when disturbed. During harbor dredging activity, silt and clay particles may be suspended and redeposited downstream. The tolerance of the Mississippi River mussel fauna to silt and clay deposition would depend upon the species present, the rate of sedimentation and the period of time subjected to these sediment particles. Ellis (1936) reported lethal effects to mussels from as little as 1-3 cm of silt. Marking and Bills (1980), however, reported nearly 100% survival of three species (*Fusconaia undata*, *Lampsilis radiata siliquoidea* and *L. ventricosa*) when subjected to a 5 cm silt overlay for 96 hours.

#### 5.4 FUTURE DISPOSAL EFFECTS

Spoil disposal from main channel dredge sites is not expected to affect the water quality near the disposal sites in the Rock Island District (USACOE 1978); however, hydrologic and habitat changes will occur. Spoil placement may result in an unstable substrate which is subject to downstream transport during high flow periods. Dredge spoil closures of side channel and backwater habitats as a result of sand carried off a disposal site have been observed at several sites in the Mississippi River (Fremling et al. 1979; R. M. Baker, USACOE, personal communication, 20 August 1979).

Effects of future spoil placement are more of a concern at the present sites than are dredge cut impacts. Dredge spoil is most frequently placed adjacent to the dredge cut in channel border habitats. In the present survey, the greatest mussel densities usually occurred in channel border habitats, and the Endangered *L. higginsii* occurred near two historic disposal sites.

Mussel mortalities can be expected as a result of overlays of sediment from dredge spoil disposal or encroachment. Silt is commonly encountered in harbor dredge spoil. As previously discussed, Ellis (1936), and Marking and Bills (1980) reported conflicting results on mussel mortality from silt overlay experiments. Sand is the predominant spoil from channel dredge sites. Marking and Bills (1980) indicated that survival of *L. r. siliquoidea* was greater than 50% in 25 cm of sand overlay; however, *Lampsilis ventricosa* had greater than 50% survival only in sand overlays of 15 cm or less.

The impact of dredge spoil disposal on the Mississippi River mussel fauna will depend on the disposal methods utilized. The proposed types of disposal include: 1) open water disposal; 2) shoreline disposal; 3) terrestrial disposal; and 4) removal from the floodplain.

Open water disposal potentially has the most adverse effects. A serious problem in open water disposal is the possibility of stable sand and gravel substrate of mussel beds being covered and eliminated for future colonization. In some instances, however, open water disposal can result in creating a habitat favorable for certain mussel species.

Shoreline disposal is likely to influence few mussels since few species occupy this shallow shoreline habitat. However, sediment encroachment from the disposal site due to back-washing during disposal or flooding could possibly disturb nearby mussel assemblages. In addition, downstream habitats can be destroyed or altered because of dam closures resulting from spoil transported during flooding.

A minimal amount of damage to the aquatic community is caused by terrestrial disposal of spoil. Island or bank disposal sites with dike construction for confinement of the dredge slurry result in little or no runoff, although spoil encroachment may occur during flooding.

The removal of dredged material out of the floodplain creates no deleterious effects upon mussels. Placement of dredge spoil out of the river floodplain would be the preferred disposal method, but it is much more difficult and expensive than the other methods. This disposal can be accomplished by the placement of spoil in barges for transporting or by pumping the dredged material onto the land side of the levee.

## 6.0 RECOMMENDATIONS

### 6.1 RECOMMENDED MITIGATIVE MEASURES

1. Dredge spoil should not be placed in the area of the Iowa disposal site at the Goetz Island Site (Pool 11) because of the presence of the Endangered Lampsilis higginsii immediately downstream.
2. The Endangered L. higginsii occurred at the downstream end of the Iowa island disposal and upstream from the Illinois island disposal at the Steamboat Slough Site (Pool 14). Recently killed specimens of L. higginsii and the only survey record of Lampsilis anodontoides fallaciosa were also collected near the Illinois island disposal. These areas should be protected from spoil encroachment and excess sedimentation resulting from future spoil disposal. The USACOE and USFWS agreed upon not using the Iowa disposal for future spoil placement and also proposed that the landward side of the Illinois disposal island be diked to prevent adverse sand encroachment during future disposal activity.
3. The area downstream from Andalusia Boat Harbor (Pool 16) yielded one individual of the special status species Cumberlandia monodonta in the present survey and the Endangered L. higginsii in a previous survey. These populations should be protected from the effects of future dredging and dredge disposal at Andalusia Harbor. The silt and clay substrate of the harbor is potentially harmful to freshwater mussels and should be placed in a confined disposal.
4. Caution should be taken to avoid the abundant main channel mussel assemblages when dredging is conducted at the Lainsville Lower Site (Pool 13) and Benton Island Site (Pool 18). These mussels are in deep water areas which will not require dredging.
5. Abundant mussel faunas immediately outside of the main channel which were observed at several sites in the present study should be protected from future dredge cuts. Dredge volume should be kept to a minimum and at a safe distance from the mussel assemblage.
6. The dense mussel assemblages which have been observed near potential disposal sites should be protected from future dredge spoil disposal. To avoid sediment encroachment, spoil should be placed in a confined disposal, at an alternate site, or in an area where future downstream movement of the spoil would not affect the mussel populations.
7. Future dredge spoil should be placed in areas which will not change nearby aquatic habitats. Delicate backwater areas such as sloughs, side channels and ponds should not be altered by spoil placement or future runoff from the disposal during floods. These habitats are commonly utilized as nurseries for juvenile and young adult of several mussel species.
8. Future dredging in environmentally sensitive areas should be conducted with a dipper or clamshell type of dredge rather than the hydraulic (cutterhead) dredge. The dipper or clamshell dredge reduces the amount of sedimentation and lessens the chance of disturbing nearby mussel assemblages.



9. Stable gravel substrates provide a favorable habitat for many mussel species. This type of substrate is especially rare in the lower pools of the Rock Island District and should not be disturbed during dredging operations.

## 6.2 RECOMMENDATIONS FOR FUTURE STUDIES

1. The Endangered Lampsilis higginsii was collected at several locations in 1979-1980 and valuable data was obtained from these collections. Intensive research of this species is needed, however, to provide definitive information on the autecology of the adults and juveniles in relation to channel-maintenance activity. The taxonomic differences between L. higginsii and Lampsilis orbiculata also need to be resolved.
2. Continued studies are required to determine the present status of Endangered Proptera capax, special status species Leptodea leptodon and rare Simpsoniconcha ambigua in the Upper Mississippi River. These species were not collected live in the 1979-1980 survey. Further surveys of lentic habitats in the lower pools of the river may yield live individuals of P. capax.
3. Recent investigations of Sylvan Slough in Pool 15 reported large numbers of the special status species Cumberlandia monodonta in pockets of fine grain sediments among rubble. Similar habitats in other sections of the river should be surveyed to determine the relative abundance of this species.
4. Hydrologic studies are needed during dredging operations to determine the extent and amount of increased downstream sedimentation when conducting dredge cuts and disposal. In addition, tracing the movement of dredge spoil through time is needed to reveal the eventual downstream impact of the disposal on downstream habitats and mussel faunas.
5. In the present study, a sandy shoal stabilized by aquatic macrophytes was found to be inhabited by several mussel species' juveniles. Other similar environments in the Mississippi River should be surveyed to determine if this habitat is preferred by juveniles. The possibility of utilizing dredge spoil to create comparable stable shoals needs to be investigated.
6. Stable backwater areas created by spoil disposal along the channel border were frequently the most densely populated habitats in the lower pools of the Rock Island District. The results of making similar backwater habitats with dredge spoil needs to be determined.
7. The common occurrence of juveniles drifting in the main channel, as described by Fuller (1978), needs further quantitative study to determine the extent of dredging impact on these populations.
8. Although the brail, or crowfoot bar, is the most versatile and convenient mussel sampling device, it has been proven to be an extremely inefficient sampler, especially for small individuals (<0.1% efficiency). A more effective sampler is needed for surveying extensive areas.

9. Diver-sampling should be included in all future studies to provide quantitative data concerning the mussel assemblages of the Mississippi River.
10. A sampling device similar to the mussel rake utilized in the present study should be used in all future investigations to adequately sample juvenile and small mussels.

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APPENDIX A



Table A-1. Length-frequency distribution of *Amblyma peruviana* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11				11 <sup>a</sup>	11				
12			2	1	4	2			
13		4		5	8	2			
14	2	10	1	4	6				
15				2	6	2			
16			1	2	15	3			
17		2	1	3	17				
18		5	3	4	8	2			
19		3		1	6	3	1		
20		1	6	6	13				
21	2	1	2	1	3	6			
22	1	3	4	2	6	14			
24					8	2			
Total	5	29	20	42	111	36	1		

<sup>a</sup>Number of individuals in each size class.

Table A-2. Length-frequency distribution of *Fusconaia undata* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>89
11		2 <sup>a</sup>		3	8	11			
12					2	4			
13		1	4	1	1	6	2	1	
14	1	7	3	2	5	4	1		
15					2	5	1		
16					3	8	3		
17		1			5	16		1	
18		1		2	1	5	7		
19	1	3	5	1					
20				3	5	8	1		
21									
22		5	1		1	1	1		
24		1			1	5	3		
Total	2	21	13	12	34	73	19	2	

<sup>a</sup>Number of individuals in each size class.

Table A-3. Length-frequency distribution of *Megalonaias gigantea* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11									1 <sup>a</sup>
12							1	8	
13		1						1	1
14									
15							4	7	
16						2	3	6	1
17						1	8	9	4
18				1			4	9	3
19							2	1	1
20									
21									
22								3	
24							3	7	
Total		1		1		3	25	51	11

<sup>a</sup>Number of individuals in each size class.

Table A-4. Length-frequency distribution of *Quadrula metanevra* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>89
11		1 <sup>a</sup>							
12									
13						1	1		
14			1		2				
15						2			
16						4	1		
17						3	10		
18						4	6	2	
19							1		
20									
21							1		
22									
24						1			
Total		1	1		2	15	20	2	

<sup>a</sup>Number of individuals in each size class.

Table A-5. Length-frequency distribution of *Quadrula nodulata* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>89
11			2 <sup>a</sup>	2	2	1			
12				1	2				
13		1			1	1			
14	1	2	9	8	3				
15			3	5	2				
16			3		4	4			
17				1	3	4			
18				5	3	4			
19				1	1				
20					3				
21		1			1				
22		4	1	3	8	3			
24	1	2	1		4	2			
Total	2	10	19	26	37	19			

<sup>a</sup>Number of individuals in each size class.

Table A-6. Length-frequency distribution of *Quadrula pustulosa* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>89
11		1 <sup>a</sup>	6	8	7	2			
12			2	3		1			
13				2	2	3			
14	6	4	6	9	5	2			
15		1		3	5	2		1	
16		1	1	2	8	15	4		
17	1	3		2	7	10			
18	1	3		3	7	10	1		
19	2			3	4	1			
20				6	12	1			
21		1			2	3	1		
22			1	5	5	6	1		
24		1		6	1	2			
Total	10	15	16	46	70	57	9	1	

<sup>a</sup>Number of individuals in each size class.

Table A-7. Length- frequency distribution of *Quadrula quadrula* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>89
11	1 <sup>a</sup>	1	1	2	4	6	8		1
12					2		5	3	
13					2	3	3	2	
14		2	2		6	3	8	2	
15					3	5	2		
16					1	1	6	5	
17						5	10	5	
18	1	2	3		1	6	8	4	1
19							9	1	
20				1	4	2		1	
21		1	1	1		1	5	2	
22						10	4		
24	1				2	4	2	1	
Total	3	6	7	4	25	46	70	26	2

<sup>a</sup>Number of individuals in each size class.

Table A-8. Length-frequency distribution of *Actinonaias carinata* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11									
12									
13									
14									
15						2 <sup>a</sup>	1		
16					1	8	5		
17					1	3	1		
18				2		11	1		
19				1					
20									
21									
22									
24									
Total				3	2	24	8		

<sup>a</sup>Number of individuals in each size class.



Table A-9. Length-frequency distribution of *Anodonta corpulenta* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11						3 <sup>a</sup>	8	2	
12						1	1		
13						2	5	2	
14			1		1	8	11		
15									
16		2	2	1	3	1	4	2	
17						3	4	3	1
18			4	4		3	10	7	
19		1	1	1		1	1		
20						1	1		
21			2			1		1	
22						1	1	4	
24						2	1		
Total		3	10	6	4	27	47	21	1

<sup>a</sup>Number of individuals in each size class.

Table A-10. Length-frequency distribution of *Arcidens confragosus* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11			1 <sup>a</sup>	1	1				
12						1			
13									
14									
15									
16	2	1		1	2				
17				2		7			
18					1	6	4		
19									
20									
21									
22									
24									
Total	2	1	1	4	4	14	4		

<sup>a</sup>Number of individuals in each size class.

Table A-11. Length-frequency distribution of *Lampsilis ventricosa* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11		1a	1	3	7	6			
12			1	4	3	2			
13				5		9	2		
14		1	2	3	6	5			
15				2	1	7			
16					2	16			
17					2	16	3		
18			1		2	15	2		
19					5	6			
20					1				
21					1	1			
22				2	4	4	5		
24					2	3	1		
Total		2	5	19	36	90	13		

<sup>a</sup>Number of individuals in each size class.

Table A-12. Length-frequency distribution of *Leptodea fragilis* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11	4 <sup>a</sup>	3		13	2	1			
12				2					
13									
14	1			1	3		1		
15									
16	2	1			2	4			
17	3	4	3	2			1		
18	4	3	1	1	2	5			
19		2		7	2				
20									
21		1		1					
22				1	1	3	1		
24									
Total	14	14	4	28	12	13	3		

<sup>a</sup>Number of individuals in each size class.

Table A-13. Length-frequency distribution of *Leptodea laevis* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)						
	<20	20-39	40-59	60-79	80-99	100-119	120-139
11		3a	9	3	3	1	
12				4		1	
13		1	3	3	4	5	
14		3		7	4	2	
15				1			
16	1	6	2	5	1	3	
17				1	2	1	
18	2	1	6	2	3		
19		2	2	2	4	1	
20					1		
21		1			1		
22		2	5	2	6	3	
24		1		1	2	3	
Total	3	20	27	31	31	20	

<sup>a</sup>Number of individuals in each size class.

Table A-14. Length-frequency distribution of *Obliquaria reflexa* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11		3 <sup>a</sup>	7	9	3				
12			1		1				
13		3	4	5	10				
14	3	9	7	3	2				
15				4	1				
16			2	5	7				
17			1	5	1				
18	2	1	3	8	5	3			
19		2	5	3	1				
20			4	3					
21	2	4		10	3				
22		7	9	8	4	1			
24		1	1	3	4	1			
Total	7	30	44	66	42	5			

<sup>a</sup>Number of individuals in each size class.

Table A-15. Length-frequency distribution of *Obovaria clivaria* from selected sites in the Mississippi River, 1970-1980.

Pool	Size Class (mm)								
	<20	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>89
11			1 <sup>a</sup>	6	7	7	1		
12			6	1		3	1		
13	1			3	8	9	4	1	
14	1	4		3	4	5			
15			1	3	2	4			
16	1		1	2	13	11	8		
17				4	4	12	1		
18				3	6	10	3		
19			1	6	1	2			
20			3	3	1				
21					2	1			
22				2	8	8			
24					1	3			
Total	3	4	13	36	57	75	18	1	

<sup>a</sup>Number of individuals in each size class.

Table A-16. Length-frequency distribution of *Plagiola lineolata* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>89
11			1 <sup>a</sup>						
12									
13				3			1	1	
14			1		2			2	1
15							1		
16				1		2	7	6	4
17					2	2	5	7	2
18			1	1		1	4	5	1
19					1			1	1
20									
21						1		1	
22				1	2	1	1	1	2
24							1	2	
Total			3	6	7	7	20	26	11

<sup>a</sup>Number of individuals in each size class.



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SURVEY OF FRESHWATER MUSSELS (PELECYPODA: UNIONACEA) AT 3/3  
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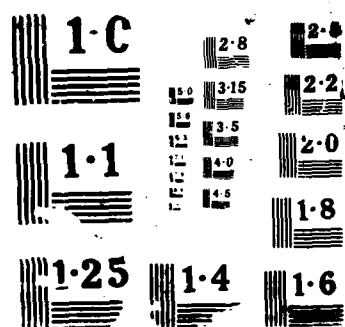


Table A-17. Length-frequency distribution of *Proptera alata* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)								
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159
11			1a	2	7	6	3		
12						1	2	1	
13									
14			1	4	1	2			
15	1				1	1	1	3	
16	3	1		1		5	17	2	
17					1	2	6	1	
18					1	5	4	1	
19		1	1		2	5	2		
20						1			
21		1			1		1		
22					1	1	2	2	
24					1		1		
Total	4	3	3	7	13	29	39	10	

<sup>a</sup>Number of individuals in each size class.

Table A-18. Length-frequency distribution of *Truncilla donaciformis* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)					
	<10	10-19	20-29	30-39	40-49	>49
11	2 <sup>a</sup>	7	13			
12						
13			2	1		
14	1	2	9	1		
15						
16	1	5	1			
17		3	6	1		
18	3	3	11	1		
19		3	11			
20						
21		1	2	1		
22		2	4	3		
24			1			
Total	7	26	60	8		

<sup>a</sup>Number of individuals in each size class.

Table A-19. Length-frequency distribution of *Truncilla truncata* from selected sites in the Mississippi River, 1979-1980.

Pool	Size Class (mm)					
	<10	10-19	20-29	30-39	40-49	>49
11	1 <sup>a</sup>		9	9	3	
12						
13				5	15	2
14			1	1	4	
15				1		
16				1		
17		2	2	2	8	
18	1		1	4	5	
19	3		2	1		
20				1		
21			1	2		
22			1	3		
24				1		
Total	5	2	17	31	35	2

<sup>a</sup>Number of individuals in each size class.

Table A-20. Length-frequency distribution data for infrequently collected mussel species from selected sites in the Mississippi River, 1979-1980.

Taxon	Size Class (mm)									
	<20	20-39	40-59	60-79	80-99	100-119	120-139	140-159	>159	
<u>Anodonta imbecillis</u>	4 <sup>a</sup>	7	8							
<u>Carunculina parva</u>	10	5								
<u>Cumberlandia monodonta</u>							1			
<u>Elliptio dilatatus</u>					1					
<u>Fusconaia ebenus</u>					5					
<u>Lampsilis anodontoides</u>			1		2	3	3			
<u>Lampsilis higginsii</u>			1	2	4					
<u>Lampsilis radiata</u>			1			2				
<u>Lasmigona complanata</u>			1	2	2	2	4	2		
<u>Ligumia recta</u>						2	10	11		
<u>Plethobasus cyphus</u>					5					
<u>Pleurobema cordatum</u>				1						
<u>Strophitus undulatus</u>				1	5					

<sup>a</sup>Number of individuals in each size class.

END

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